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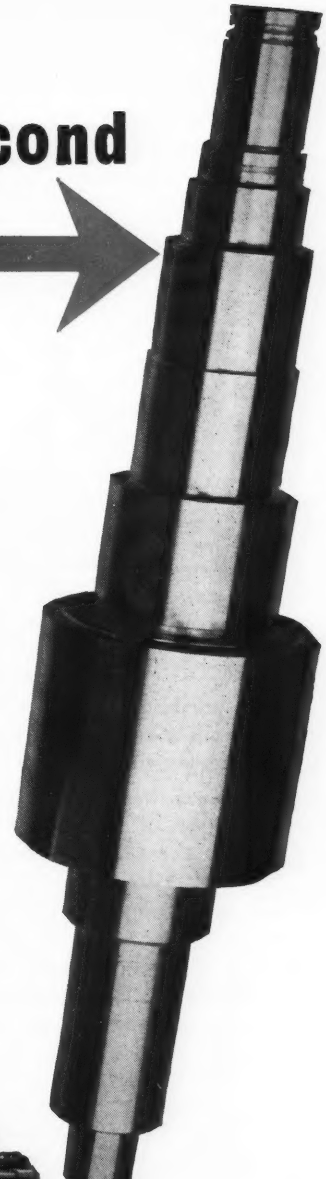

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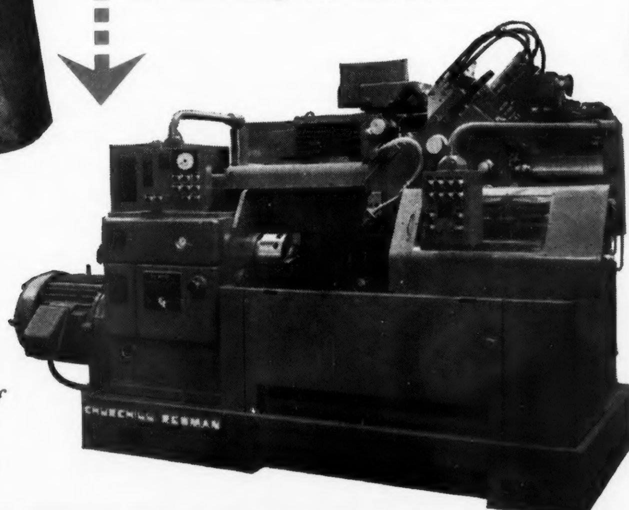

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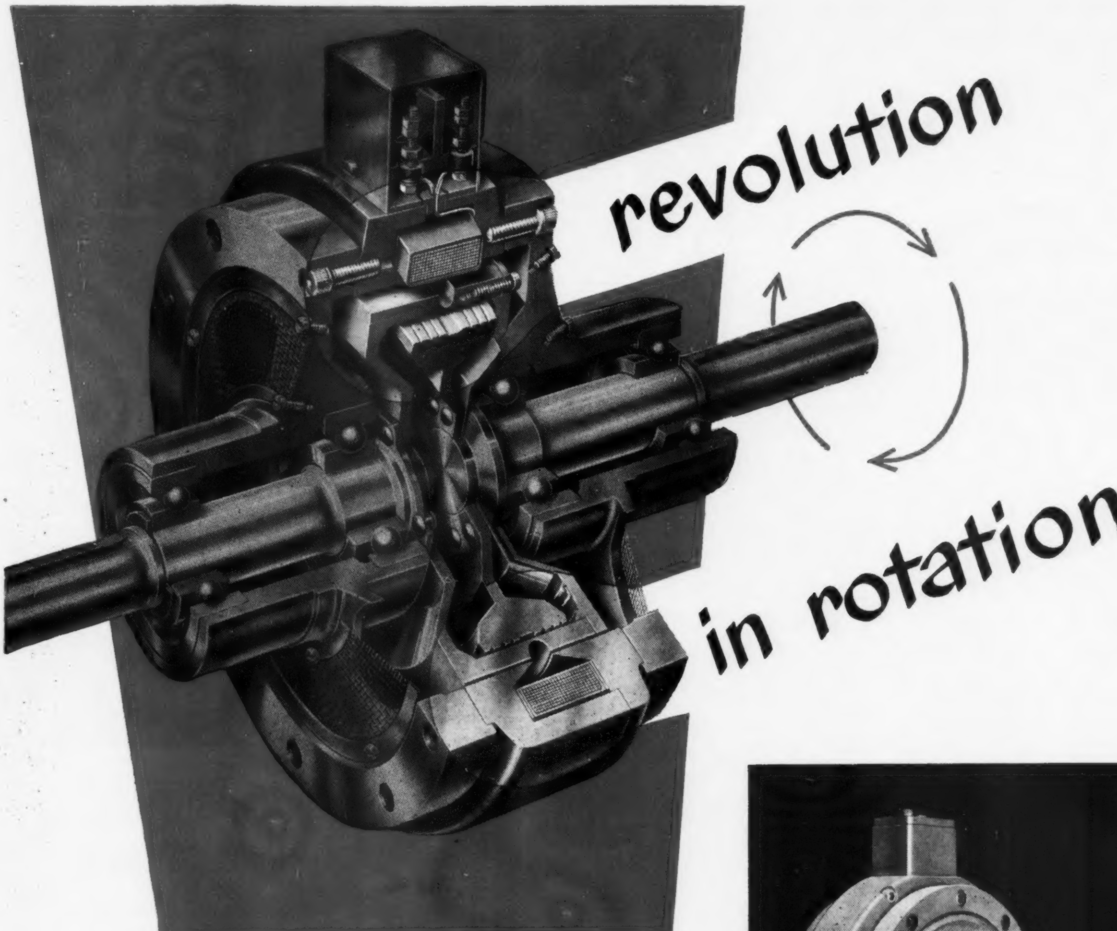

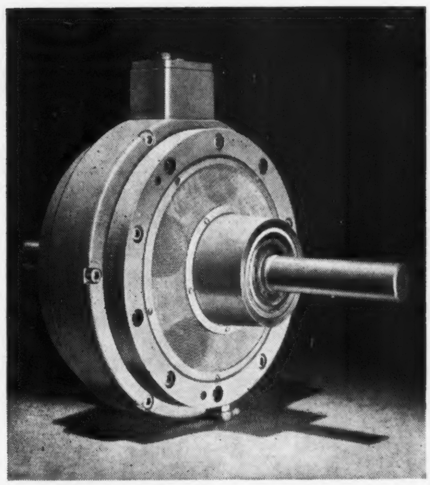

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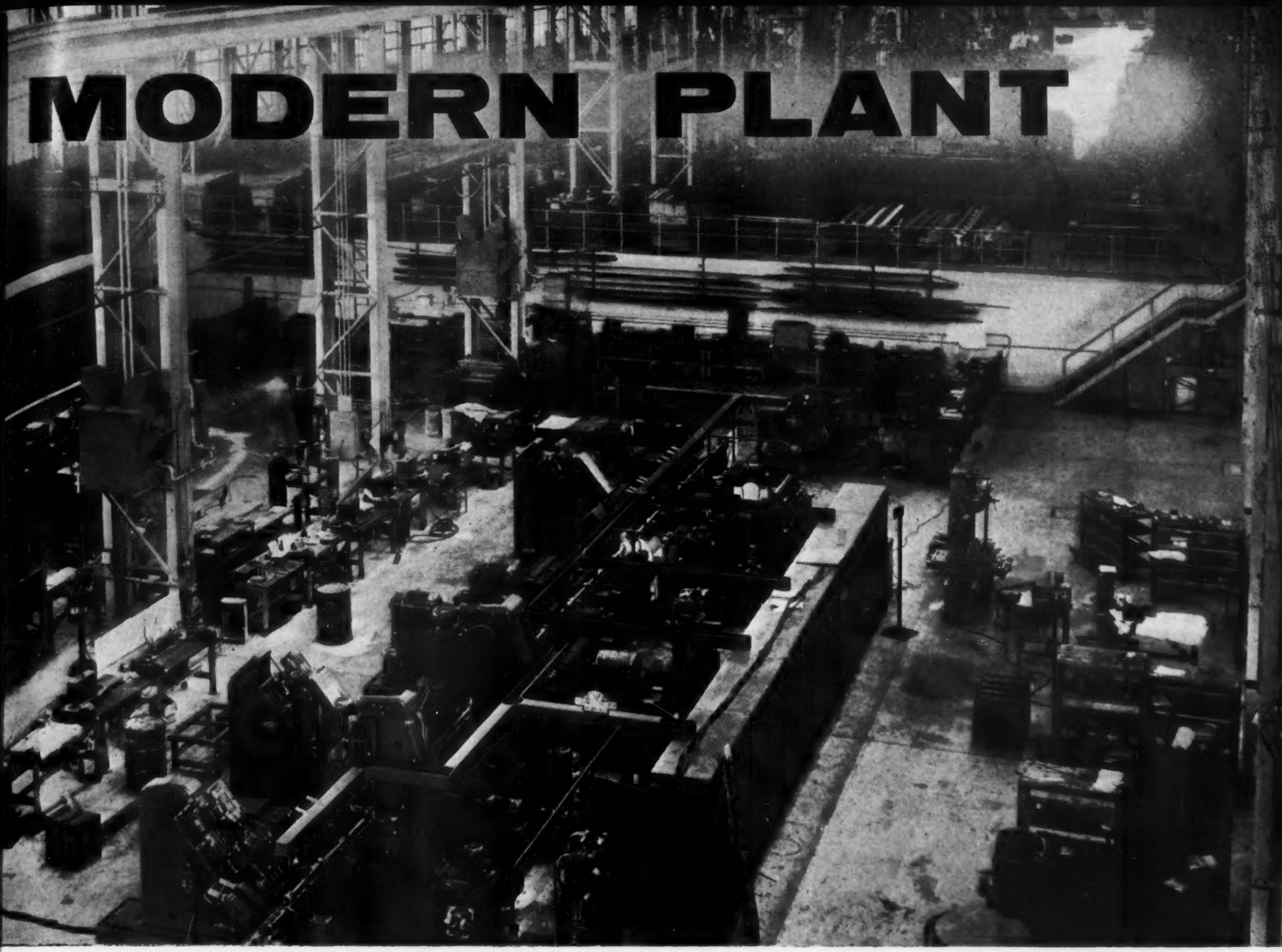

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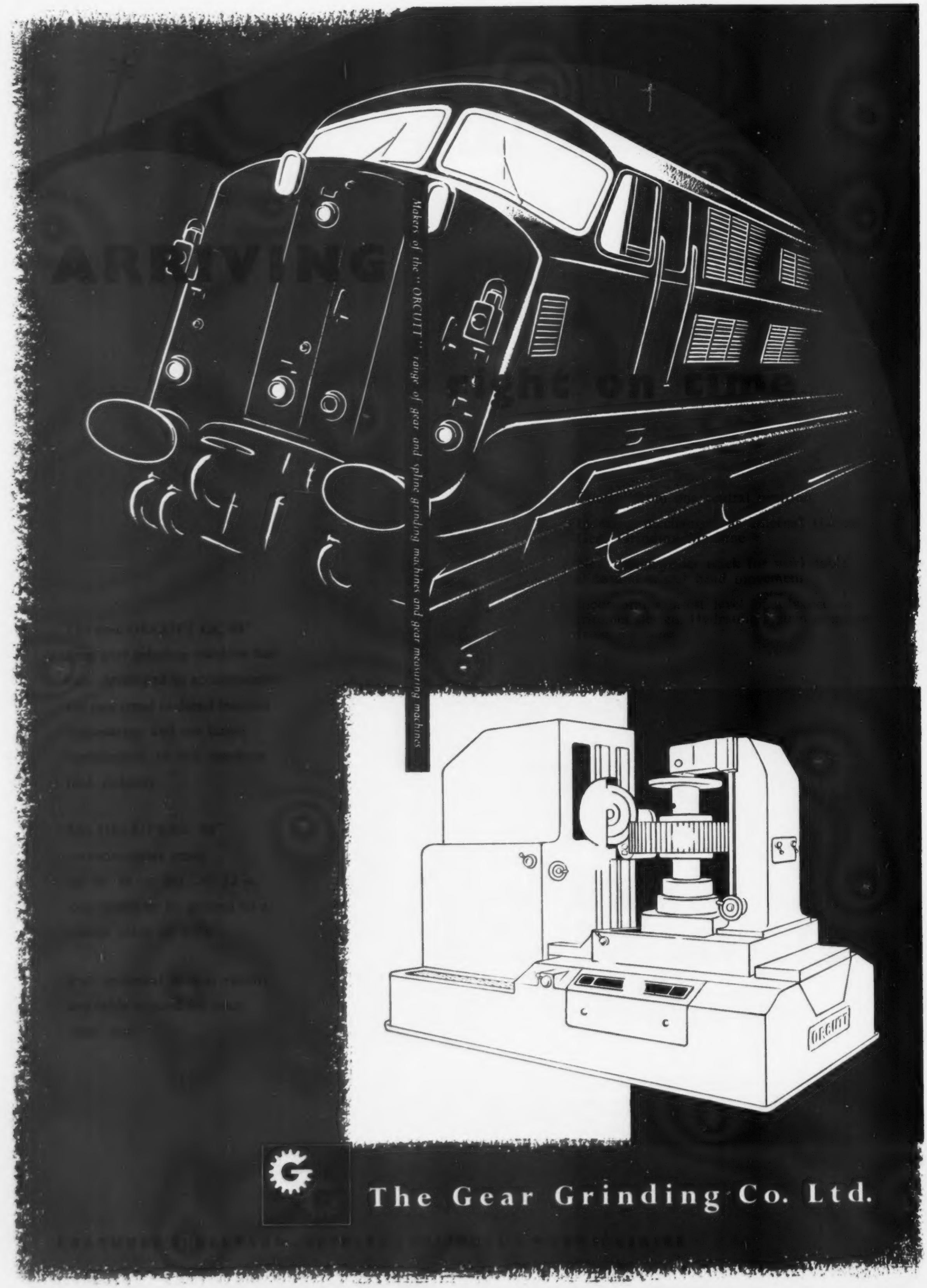
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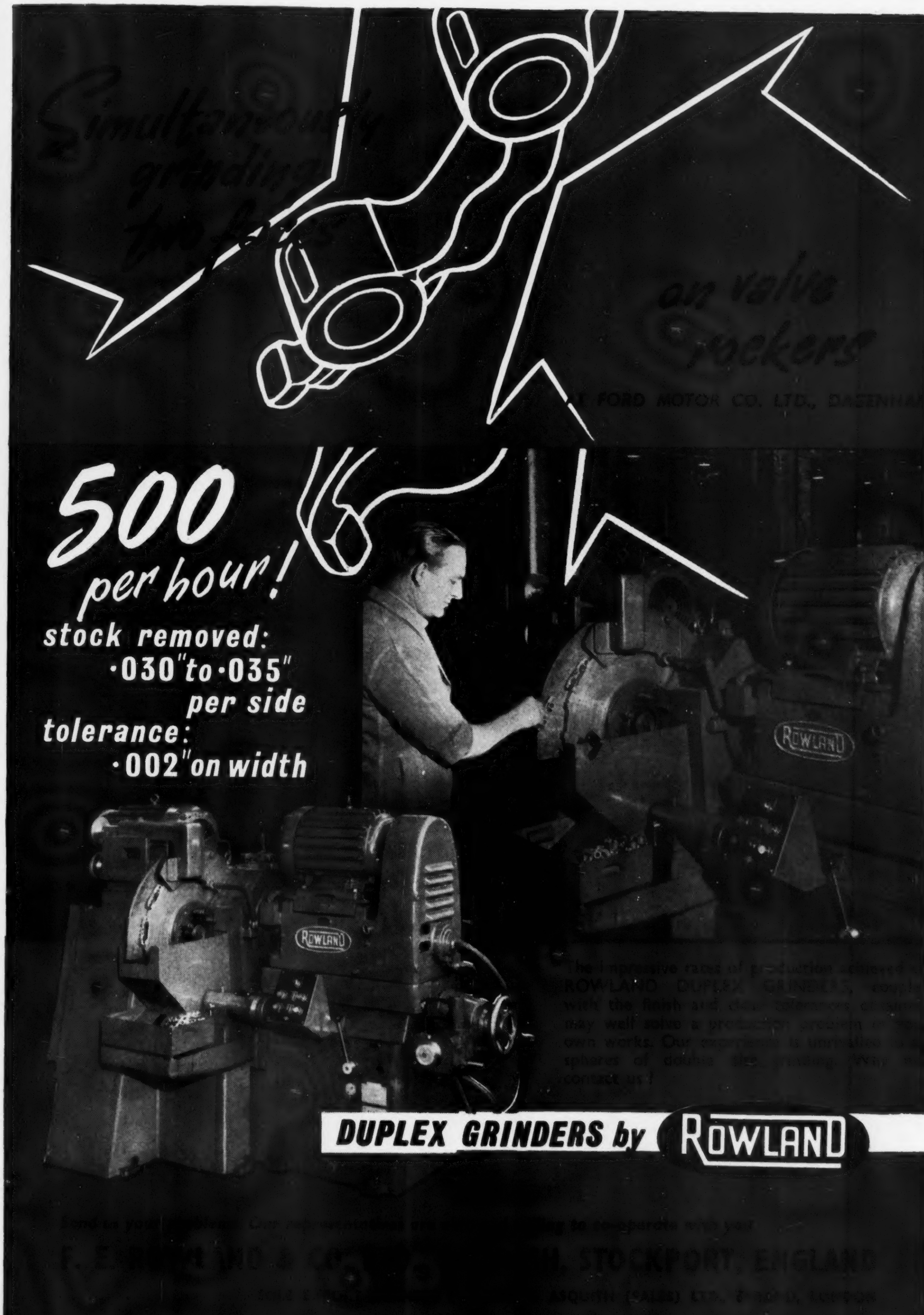
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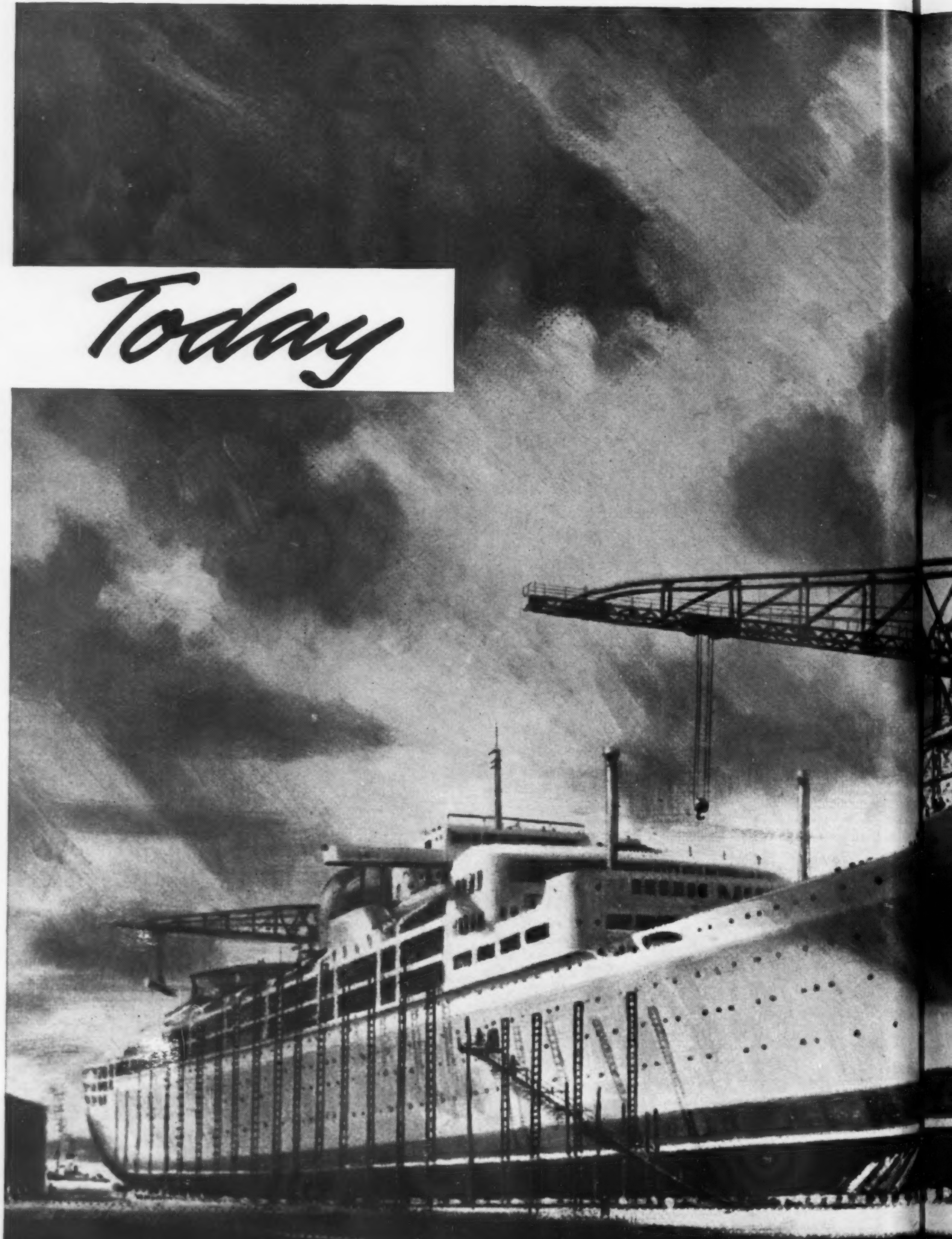
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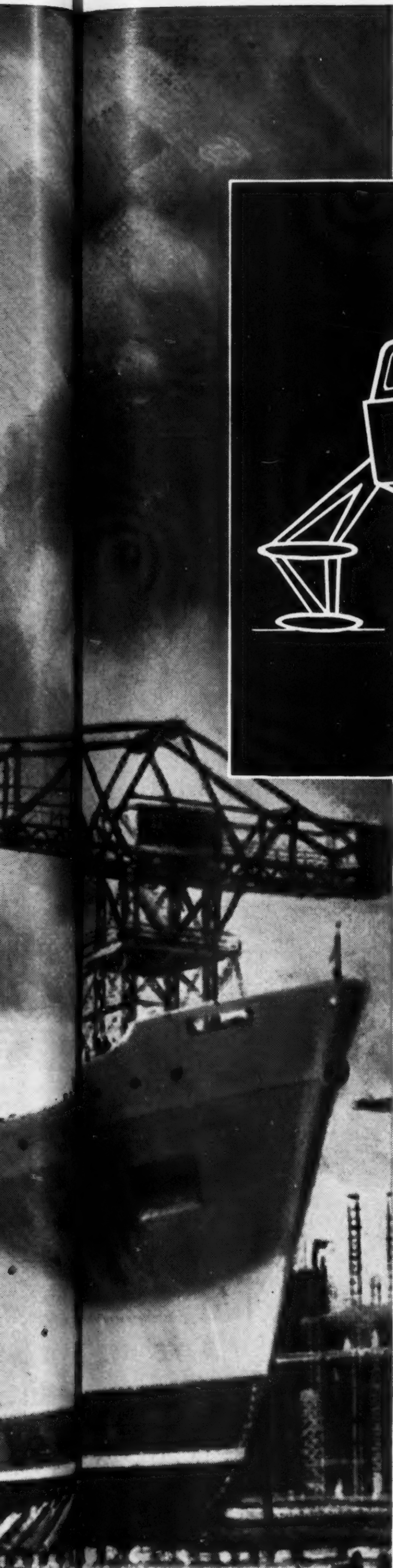

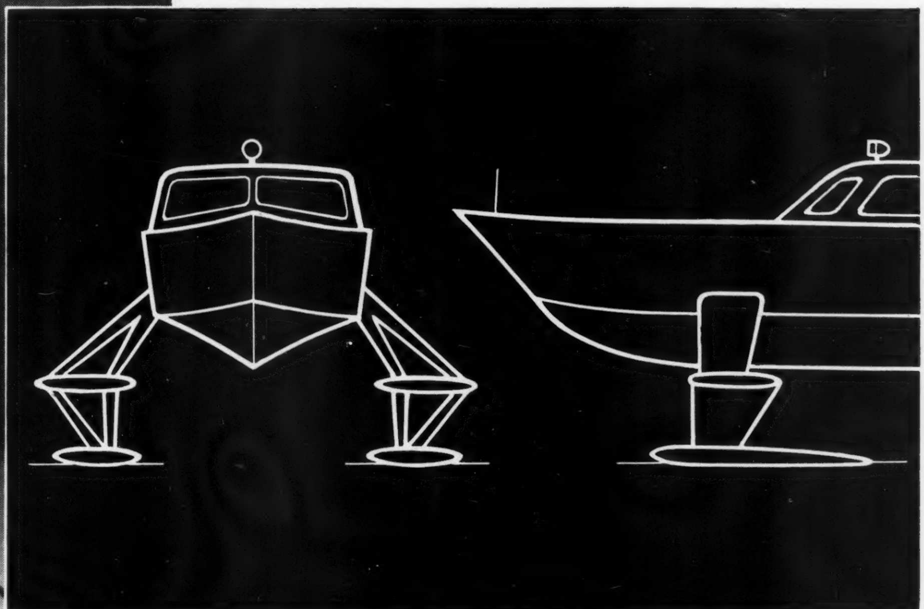

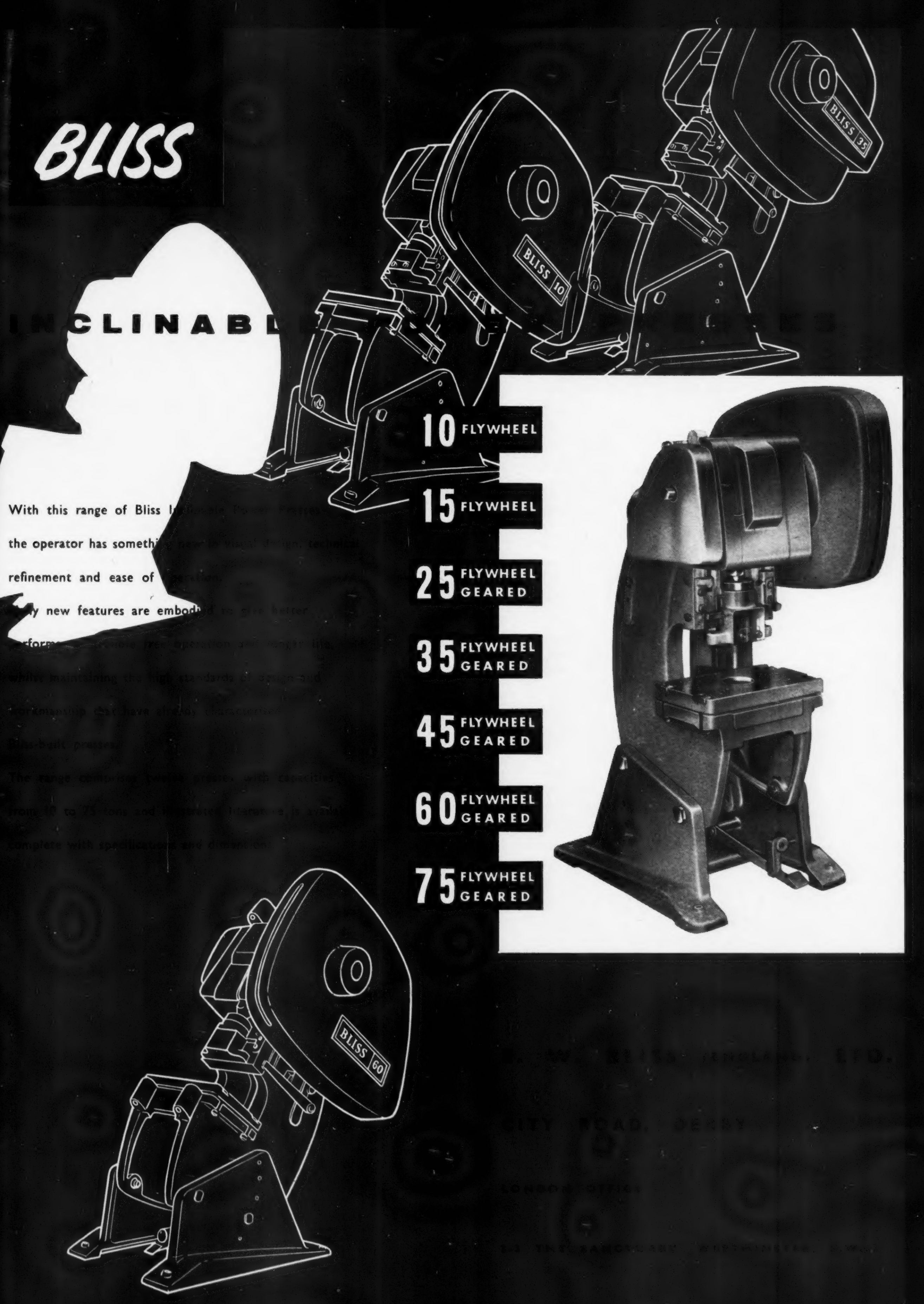

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The Institution of Production Engineers Journal
VOL. 38 NO. 7 JULY, 1959

PRODUCTION ENGINEERING AT IMPERIAL COLLEGE

A Report prepared for the Journal by
Professor O. A. SAUNDERS, F.R.S., Head of the Department of Mechanical Engineering and Dean of City and Guilds College;
Dr. J. M. ALEXANDER, Reader in Plasticity;
and R. C. BREWER, Lecturer in Mechanical Engineering

THE question of how production engineering should be taught at a University is a difficult one and the answer is probably different for each University. Imperial College has been considering this problem for a number of years. It is clear that a technological institution with a longstanding record of contribution to technology and science should be able to make a substantial contribution to the education of production engineers in this country. The main difficulty is to decide how this may best be done, bearing in mind the diversity of problems which normally confront the production engineer. The Imperial College has perhaps a certain advantage in the very diverse activities within its organisation, ranging from the very theoretical, such as nuclear reactor physics, to the very practical, such as ore and mineral dressing, with subjects such as statistics, plasticity and engineering sciences somewhere in between. Moreover, the level of these subjects ranges, in general, from first year undergraduate to postgraduate, which includes the Higher Degrees of M.Sc. and Ph.D. of the University of London, of which the Imperial College of Science and Technology is part.

Within the Imperial College, the study of engineering is carried out in the City and Guilds College which has five Departments, namely Civil, Mechanical, Electrical, Chemical and Aeronautical. It would be possible to introduce production engineering as a separate department, but this presents certain difficulties. One of these is the fact that production engineering differs from the abovementioned branches of engineering, both as regards its field of interest and the extent to which its field of interest overlaps other disciplines. The five existing departments have fields of interest in which a substantial proportion of the whole is relevant mainly to that particular branch; production engineering has a much smaller area of its own and a far larger area

where it overlaps other disciplines; moreover, it overlaps a whole range of disciplines with which the other branches of engineering are not normally in contact, e.g., the field of Human Relations involving Psychology and Sociology and the new fields which have developed from statistical mathematics. The solution has been to incorporate the activities within the Department of Mechanical Engineering, but to regard the service as available to and involving all interested departments. At the moment the Departments of Mining and Electrical Engineering are the only ones using this facility, but it has the advantage of ensuring continuity in lecturing, as compared with a programme given by several outside lecturers.

Although the Production Engineering Course at Imperial College is only a few years old, the College has made many contributions, in the past, in the field of research into production engineering problems of a technological nature. These were notably in the field of metal working and plasticity under the supervision of Professor Hugh Ford who holds the Chair of Applied Mechanics (1) - (7). It is natural, therefore, that the present activity should include a fairly complete consideration of the technological aspects of production. The course is thus rather broad in conception and may be conveniently divided into technological and non-technological sections.

A full-time postgraduate course is offered which lasts for one academic year. Qualification for entry is a University degree and two or three years' experience in industry although the degree requirement may be waived in the case of candidates who can show that they would benefit from the course. During the time the course has been running the applications have considerably exceeded the number of places available, which is of the order of 10 - 12, this being felt to be the maximum number of students who can be adequately supervised under present conditions owing to the re-building activities.

award of the D.I.C.

Satisfactory completion of the course leads to the award of the Diploma of the Imperial College (D.I.C.). There is a minimum of formal examinations and such examinations as exist are very much designed to test the candidate's ability to think and apply rational principles and this has led to a form of examination rather different from that usually accepted in the branches of engineering more akin to the field of natural philosophy. One of the principal factors in assessing a candidate's suitability for the award of this postgraduate diploma is his ability to consider some particular problem, technological or otherwise, and solve it under the conditions which would normally pertain in industry. For this to be a real test a period of about three months is required; to this end the course has been designed so that the formal lectures are given in the first two terms of the year, thus leaving the third term free for the problem on which the student will submit his thesis. Evidently if the student, with the agreement of his supervisor, chooses a subject outside the technological field, it is generally not possible for him to conduct his investigation within the college, due to the difficulty in providing continuous production facilities, although a problem in a field such as office organisation could perhaps be studied. The College is most grateful to several industrial companies who have assisted in making such investigations possible, particularly in view of the fact that the problem must be such as to enable the student to exercise his critical abilities.

At a higher level, it is also possible for students to proceed to the M.Sc. Degree of the University of London, the residential requirement for which is two academic years. Agreement has been reached with the University that students in Production Engineering may need to be away from the College, since an industrial company is often, in effect, their laboratory. By this agreement students are allowed to be away from College for two terms and since these are normally the Autumn and Spring terms of the second year, a period of some nine or ten months is available including vacations. The students in production engineering at Imperial College have had very diverse backgrounds, having come from, for example, various branches of engineering, science or naval architecture. These students have rarely had any extensive training in production engineering and it is thus necessary that students reading for the M.Sc. Degree should be offered some basic lectures on production engineering; this is normally achieved by arranging for the student to attend certain of the lecture courses for the postgraduate diploma in production engineering.

At the undergraduate level, third-year mechanical students may take production engineering as an optional subject. This subject is divided into two approximately equal parts, the first concerned with machine tools and the machining process and the second with industrial engineering. The first section is complementary to the compulsory first year subject " Mechanics of Manufacturing Processes " and serves to complete the consideration of the processes of production.

The academic arrangement of the postgraduate course is broadly as follows. All students are required to take three compulsory subjects :-

1. Industrial Engineering,
2. Management and Industrial Administration,
3. Statistics and Statistical Methods.

The Industrial Engineering lectures and tutorials are given entirely by the staff of the Production Engineering Group but, for the other two subjects, use is made of the specialist facilities of other Colleges within the University. Management and Industrial Administration is taught at the London School of Economics, which is a School of the University and specialises in Economics and Political Science. Imperial College has a Department of Mathematics which includes a Professor of Statistics and several members of the staff specialising in statistical methods and operations research; it thus is natural that the

third compulsory subject should be taught in that department.

In addition the student is required to attend sufficient of the following list of optional lecture courses as to give a minimum of 50 lecture-hours. The optional lecture courses are:-

1. Production Processes I,
2. Production Processes II,
3. Dimensional Metrology,
4. Gauging, Inspection and Testing,
5. Industrial Sociology,
6. Principles and Practice of Machining,
7. Economics of Production Processes,
8. Non-Metallic Materials,
9. Automatic and Numerical Control of Production Processes,
10. Operations Research,
11. Plasticity of Production Processes.

The majority of these lecture courses consist of a one-hour lecture each week for one term and thus count as 10 lecture-hours.

In selecting the subjects included in this list, their choice has been influenced by the following concepts. It is felt that the science of engineering production should not be limited solely to considerations of "industrial engineering". The technological aspects of various processes and their inter-relation with the materials used in manufacture deserve equal emphasis with industrial engineering, since a radical improvement in a manufacturing technique will usually outweigh previously optimised procedures, so that a new appraisal must be made of the situation.

The first optional subject, Production Processes I, is intended largely for students who have not had a predominantly engineering training and is a very general course on the various production processes. In the lecture course, Production Processes II, the technological aspects of these processes are considered in greater detail. The remainder of the optional lecture courses are virtually self-contained, inasmuch as they assume no particular previous knowledge of the subject. Consequently the first lecture or two of several of these lecture courses are devoted to the formulation of the problem, a consideration of how it will be tackled and a brief introduction to any new techniques or disciplines which may be required; in the case of Plasticity of Production Processes, a whole term of introductory work is undertaken and it has been found that very few students can omit this introductory work satisfactorily.

weekly seminars

One feature of the course is the weekly seminar which occupies a period of two hours, the first hour of which is devoted to a lecture, often given by one of the students, and the remaining hour to questions and discussion. This seminar period serves a two-fold purpose; firstly, since each student is required to give one lecture during the year, he acquires some experience in the marshalling of facts into a form suitable for presentation as a lecture including the very valuable experience of subjecting himself to questions and discussion. Secondly it enables a number of subjects to be dealt with which are either isolated or highly specialised and consequently difficult to incorporate into the formal lecture courses. These latter lectures are for the most part given by outside experts and on some occasions are coupled with a visit to the industrial company with which the lecturer is associated.

The accusation has often been levelled that engineering courses, in both technical colleges and universities, tend to place too much emphasis on what might be called the "blackboard solution of problems". The works visit is often regarded as one way in which this can be partially remedied, but it is felt that very often the traditional half-day visit to a works is more a test of the physical endurance of the students than a process of industrial enlightenment. With this in mind, three or four visits are arranged during the year to different industrial companies, each visit lasting two or three days and involving lectures given by the staff of the companies. The students are conducted round the works or selected parts of the works in a manner aimed at giving them the best appreciation of the problems facing the company and the way in which they have been or are being solved. It will be appreciated that visits of this nature are not easy to arrange and, indeed, would be quite impossible but for the very generous co-operation of several of our more progressive companies.

The aim throughout the course has been to recognise that differences exist in the educational approach to production engineering problems and every effort has been made to allow the studies to proceed in the best possible way and not be hampered by preconceived notions based upon many years' experience of a general engineering education.

research work in production engineering

In this account of the research work which is in progress in the Imperial College, no mention will be made specifically of research into forming processes which is undertaken as part of the plasticity programme within the field of Applied Mechanics. The research work undertaken within the Production Engineering Group falls broadly into three categories: (a) technological, (b) industrial engineering, (c) human relations. These will be considered in turn.

(a) technological:

In view of the previous remarks about the research in plasticity of forming processes, it is not surprising that the bulk of the technological work has centred on the machining process. Two studies have been made on the machining process at low speeds; in one of these, an experimental method was used to derive a slip line field. This was in contrast to, and in some ways complementary to, the work done by Oxley at Leeds University (8). Work is still proceeding on the other study, in which the mechanism of deformation is being investigated metallurgically. This work is rather more qualitative than the former

study but it covers a wider range of variables and has a two-fold object :- to discover the extent of the zone of plastic deformation and the way in which this changes with strain rate. An experimental investigation has just been concluded on the heat balance of the shaping process. Up to this time, most experimental programmes of heat balances for machining processes have centred on the continuous processes, such as turning and drilling which has restricted the theoretical analyses virtually to the orthogonal turning operation. It is hoped that this latest work will give some information on the effects of the intermittent heat generation in processes such as shaping.

A further investigation which is rather on the border-line between technological and industrial engineering interests, has been concerned with the utilisation of banks of automatic screwing machines. The allocation of a number of automatics to a setter and a feeder is obviously a problem in machine interference but is not a problem for which a ready solution exists. With the co-operation of two industrial companies, an experimental programme was undertaken involving between 100,000 and 150,000 observations. The analysis of these observations is proceeding in parallel with theoretical work based on statistical concepts and it is hoped that a significant contribution may be made to this particular problem in the field of interference.

(b) industrial engineering:

There are three main industrial engineering problems being studied. The first is concerned with an optimum procedure for inspection in a factory engaged in batch production. Up to now this problem appears to have been solved in industry on a rather haphazard basis, often using the concept of the travelling inspector. Little regard seems to have been given to the optimisation of inspection procedures in batch production factories and the experimental programme has revealed to date that incidence of wasted time due to interference is higher even than was expected. As part of the optimisation, queuing theory is being used to assess the number of inspectors required in relation to either the number of operators or the inspection work.

The second study is concerned with the problem of a " feeder " division in a medium-sized manufacturing company. The idea behind such a division is that it should act, in effect, as a sub-contractor to the main manufacturing divisions and would be able to operate efficiently because it can guarantee a better utilisation of facilities than any one of the main divisions. This is particularly true of expensive special purpose machinery. The problem, however, is not as simple as this. To mention one thing only, it might be economically more profitable to sub-contract to an outside company. Another point which may be equally important is the question of delays occasioned by the fact that the feeder division has to gear its progress of work to the other manufacturing divisions and it may not always be able to do this in a satisfactory way. This can lead to a manufacturing division having to wait for a sub-contract to be completed by the feeder division, under circumstances in which the work could have been done immediately had it been placed on external sub-contract. This general problem is being studied for one industrial company and although the particular results will be unique to that company, it is hoped that many broad conclusions may be drawn regarding the usefulness of feeder divisions.

The third industrial engineering study is concerned with a basic cybernetic problem, namely the flow of information through a system and the successful feed-back of information which is necessary to ensure that adequate control can be exerted. It is conceived largely as a control problem (speaking technologically) but obviously there are many differences between the functioning of a physical closed loop system and that of a complex industrial organisation. This is a pressing industrial problem which has been solved on a largely ad hoc basis and it is becoming increasingly apparent that the natural process of making control more complex is proceeding at a faster rate than man's steps to simplify it. This type of problem is not easy to formulate but the fact that it is being studied at all, inevitably leads to some improvement within the organisation concerned. It is hoped that this study will at least contribute something to our fundamental knowledge of transmission of information in a complex organisation.

(c) human relationships:

The research undertaken recently in South East Essex under the direction of Miss Joan Woodward indicated that similarities in structure between manufacturing companies are based, not so much on their size or type of industry, but on the production system operating in them. It also suggested that the nature of the production spstem has a marked effect on both management behaviour and relationships.

This study was rather limited in nature and it was impossible to do much more than compare three broad categories of production, viz., unit, mass and process. The report (9) aroused considerable interest in many circles and the Production Engineering Group at Imperial College decided to carry the work further. Initially, this is involving the consideration of a system for classifying manufacturing concerns, all types of production and production control being covered. This work is being undertaken mainly by post-graduate students.

With the co-operation of Miss Woodward, it is hoped to extend the work in two further stages; the first of these is fairly well-defined and will consist of surveying recent work done in the Human Sciences field related to the system of classification referred to above. The second stage would consist of a study of the human behaviour and relationship associated with the different types of production control. Since this is connected closely with the outcome of the previous work it is not possible to say much more than that the study would concern itself with three different levels, viz., operator behaviour, supervisory relationships and management structure.

work done for D.I.C. theses

It has been mentioned previously, that one of the conditions for the award of the D.I.C. is that the student should undertake some investigation or research and submit an account of it in the form of either a thesis or a dissertation.*

The work undertaken for this purpose may form part of the general programme of the Production Engineering Group or may be quite independent of it. Typical of the former are the investigation into the economics of numerically-controlled machine tools and the work mentioned above, on classification of production systems. Recent individual studies have been concerned with the following topics: the establishment of a quality control system for a factory working to exceptionally close tolerances; determination of set-up times for automatics using synthetic methods; an investigation into the possibility of using spot-welding in shipyards for the construction of divisional bulk-heads.

short courses

In common with other activities in the Department of Mechanical Engineering, a course of three weeks duration is given each year, mainly to cater for the needs of industry. This year the title of the course is "Plasticity of Production Processes" and technological aspects of production engineering have received emphasis. In brief, the first week of the course is devoted to the fundamentals of plasticity theory, the second week to large scale processes such as rolling, extrusion, and forging, the third week to final shaping processes such as deep drawing, wire drawing, impact extrusion and machining. In other years, the emphasis will be placed on other aspects of engineering production. Candidates for these courses are in general responsible engineers from industry, and in order to keep them abreast of current development, experts who are eminent in their own particular field are invited to contribute lectures.

** The University of London makes a definite distinction between a thesis and a dissertation; the former is concerned with original research whilst the latter is an "ordered and critical exposition of existing knowledge".*

In conclusion, it is hoped that this somewhat brief review of the activity in production engineering at Imperial College will have given a broad idea of the aims and present achievements in this field. The staff feel that the target of providing a well balanced training as between technological and non-technological subjects has been attained, whilst allowing the students a significant degree of choice in their detailed courses.

Mention should be made here of the many industrial companies who have assisted the College in its production engineering activities, either by providing facilities for research (both long and short term), by arranging visits to their works or in providing lecturers with contemporary knowledge of specialised aspects of production engineering. It would not be invidious to make special mention of Production-Engineering Ltd., who have used their considerable facilities to foster interest in the course and to establish a liaison between the College and many of the companies mentioned below :-

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Production-Engineering Ltd., London.
Quasi-Arc Ltd., Bilston.
Siemens, Edison, Swan Ltd., Woolwich.
Vauxhall Motors Ltd., Luton.
William Denny and Brothers Ltd., Dumbarton.

GENERAL REFERENCES

1. P. W. Whitton and H. Ford. "Surface Friction and Lubrication in Cold Strip Rolling." Proc.I.Mech.E., Vol. 169, No. 5, pages 123 - 140.
2. G. Lianis and H. Ford. "Control Equations of Multistand Cold Rolling Mills." Proc.I.Mech.E., Vol. 171, No. 26, pages 757 - 776.
3. H. Ford, F. Ellis and D. R. Bland. "Cold Rolling with Strip Tension." Journal of the Iron and Steel Institute, Part I, Vol. 168, pages 57 - 75; and Parts II and III, Vol. 171, pages 239 - 249.
4. A. B. Watts and H. Ford. "On the Basic Yield Stress Curve for a Metal." Proc.I.Mech.E., Vol. 169, No. 58, pages 1,141 - 1,156.
5. J. M. Alexander and H. Ford. "Experimental Investigation of the Process of Expanding Boiler Tubes." Proc.I.Mech.E., Vol. 171, pages 351 - 381.
6. L. E. Culver and H. Ford. "An Experimental Study of Some Variables of the Tube-expanding Process." To be published in Proc.I.Mech.E.
7. J. M. Alexander. "Deformation Modes in Metal Forming Processes." Proc. of the Conference on Technology of Engineering Manufacture, London, 1958.
8. P. L. B. Oxley. Ph.D. Thesis, University of Leeds, 1957.
9. Joan Woodward. "Management and Technology." D.S.I.R. Report, H.M. Stationery Office.

(A list of recent publications by the staff of the Production Engineering Group at Imperial College appears in Library Additions.)

THE SEARCH FOR PRODUCTIVITY IN A FOOD INDUSTRY

by MARK BOGOD, A.R.C.S., F.R.I.C., M.Inst.R.

Director,

J. Lyons & Company Ltd.

Mr. Bogod graduated from The Royal College of Science in 1921 and started work in the Laboratories of J. Lyons & Company, Ltd. in 1922. He became Manager of the Ice Cream Department in 1934, and was appointed Employee Director of the Company in 1958.

Mr. Bogod is joint author, with Dr. Lampitt, of a number of papers, mainly on milk products. In the Paper published here, he describes the application of Work Study to the production and distribution of ice cream.

THE search for productivity in J. Lyons & Company, Ltd., has been accompanied by the ever-wider application of Work Study. The expression "Work Study" is used in its broadest sense to mean the systematic investigation of a situation or an operation; i.e., the measurement of the component elements and the determination of the optimum solution, whether carried out by means of a stop watch or by any other means. The opportunities for Work Study in the food industry and the catering industry are by no means limited to the production processes; on the contrary, the scope for Work Study would appear to be as wide as the enterprise itself, with the reservation, of course, that while it can be applied to every part of the organisation, it may not prove to be an economic proposition everywhere.

It is almost a truism to say that the results of Work Study are, as a rule, specific to the problem being studied and that the aim of each study is less to adduce general rules which can be universally applied, than to discover the best way of carrying out a particular operation. This explains why it is not always economic to undertake a Work Study, for unless the job under investigation is being regularly repeated or, at least, is typical of others that are being repeated, the cost of the study is likely to exceed any possible saving and the delay in obtaining the results of the study is likely to be such as to render it valueless. The fact that a particular piece of Work Study has application only within the environment in which it has been carried out makes it desirable to explain something of the background of the studies which are to be described later in this Paper; in other words, to give a brief outline of the problems which distinguish the food industry from those industries associated more closely with engineering.

The activities of J. Lyons & Company Ltd. cover every aspect of the catering and food industries and any review of the results which have been achieved by Work Study will necessarily have to be highly selective. It would be possible to select examples from several different fields, for example, teashops, Corner Houses, bakery products, marketing, the electronic office, ice cream and so on; it would be equally possible to select all the examples from a single field and to consider the subject in depth. If the desire is to give an indication of the penetrating power of Work Study, and if the objective is to stimulate thought about the future development of Work Study—not necessarily in this Company, nor in this industry—then it would seem sensible to attempt to draw examples from as deep a field as possible, rather than from as wide a field as possible, having regard to the limits of space and time. The examples which have in fact been chosen for inclusion in this Paper are all concerned with ice cream production and distribution.

There are certain essential differences between food products and engineering products, or rather the problems which dominate food production as opposed to engineering production:

(a) A food product is usually fragile and not always self-supporting in all planes; it is not always solid; it may not be easily handled and moved; (e.g., a Swiss roll, a fruit pie—although on the other hand, confectionery, biscuits and cereals do not present similar problems).

(b) People's appetites being what they are, the individual articles produced in a food factory are usually small; they may be as small as individual portions or pieces, but are unlikely to be larger than the size of a packet which a housewife can pick up in a shop and take home. Because the individual articles are small, the number of pieces which have to be produced per unit of time or distance is correspondingly large.

(c) The price per piece is comparatively low, as little as 3d. or 6d. per piece and rarely more than a few shillings per packet.

(d) The product is usually perishable, with the result that many foods cannot be stock-piled and shelf-life is limited. From this follows the need for despatch and distribution to be closely related in time and distance to manufacture, and also that production must to a greater or lesser extent vary with sales, possibly on a weekly or even a daily basis. Apart from being perishable, food products are often unstable, that is to say, they continually change their condition, drying out or absorbing moisture as the case may be, maturing, staling or souring with the passing of time. This instability can often be countered by refrigeration.

(e) Some food products can easily be contaminated, particularly if they have a high moisture content. Usually there is a heating process (e.g., cooking or baking) which destroys possibly harmful bacteria. If there is no cooking or baking process it is often necessary to introduce a form of heat treatment known as pasteurisation, to reduce the general bacterial content and destroy any harmful bacteria which may be present. This is usually achieved by holding the product at an elevated temperature for a definite period. Pasteurisation has to be followed by rapid cooling, otherwise the bacteria may grow again while the product slowly cools through incubation temperatures. Even with this precaution it is still necessary to make certain that there is no re-contamination in subsequent processing. There are overriding requirements of hygiene which have to be met and they, in turn, have an influence on the methods and plant to be used and also the sort of operations which need to be carried out by machine or by human beings.

(f) Standardisation is of the first importance and extremely difficult; various quality control techniques are used, but the fact remains that it is still impossible to measure the two most important aspects of quality where food is concerned, viz., taste and texture. The next best thing is to measure contributory factors such as temperature, density, weight, etc.; a direct consequence being the difficulties arising out of replacing the skilled craftsman by machines which cannot " taste." Concepts of texture such as chewiness, creaminess, smoothness, roughness and so on, are not susceptible to precise definition, but some of the factors which influence texture can be measured, e.g., particle size, air-content, water-content, density and so on.

ice cream production

In 1945, as a result of wartime and post-war restrictions, production and sales of ice cream by this Company equalled half that of the best year before the War and by 1951 production had increased sevenfold. One-fifth of this additional production had been achieved by the acquisition of another factory in the North, but the production of the factory in Cadby Hall had increased to nearly three times that of its capacity before the War.

The period of rapid expansion between 1945–1951 provided an excellent climate for the encouragement of innovation and the development of ideas, all of which, although to some extent inhibited by the existence of inelastic buildings with immovable walls, were set in the long-term expectation of a continued expansion.

This work demanded not only inspired individual thinking, but also organised thinking. To achieve this, a development group was formed to include mechanical, electrical and refrigeration engineers, a

chemist, a planning engineer and operational managers (people concerned with the production and distribution of ice cream). This group or committee met once a week to initiate new developments, to consider the progress of development work already undertaken and to plan further work.

It would be as well to make clear at this point the main stages in the manufacture and distribution of ice cream. These are as follows:—

(1) Mixing
(2) Pasteurisation
(3) Homogenisation
(4) Freezing
(5) Packaging
(6) Storage
(7) Distribution to depot
(8) Distribution to retail outlets
(9) Sale to consumer.

(1) The first process consists of preparing and mixing the ingredients.

(2) The process of pasteurisation is of special importance when milk products are incorporated in a food product, and indeed for most manufactured food products that are not to be submitted to cooking before consumption. The pasteurisation process, which is designed to reduce the microbiological content of the product to a negligible quantity, without affecting the natural flavour of the ingredients, is by no means new, as its name demonstrates.

(3) Following pasteurisation, homogenisation is necessary. It will be apparent that a heterogeneous product containing a fat and an aqueous medium needs assistance to effect a mixture. Emulsifying agents, in this connection, can produce temporarily uniform mixtures, but such mixtures, as is so well demonstrated in milk, tend to separate into a creamy upper layer containing most of the fat and a lower, much thinner, almost fat-free layer. The process of homogenisation is designed to break up the fat so that the disrupted particles, although lighter than the continuous medium, are prevented by virtue of their microscopic size and the viscosity of the continuous medium, from rising to the surface. This condition is important from the point of view of maintaining uniformity of composition of the mix while being stored, and also to prevent " buttering " during the subsequent whipping operation.

(4) There are also refrigeration processes necessary for bringing down the temperature. These, broadly, are in three stages:

(a) Cooling of the liquid mix to below 40°F.
(b) Freezing the mix in a freezer, which also incorporates air in the whipping process, to temperatures 21° to 22°F.
(c) Further reducing the temperature so that the consistency of the ice cream is relatively hard.

(5) The packaging of the ice cream and indeed of any food sold in individual portions or family sizes, is a prime factor in the production process.

(6) Storage at low temperature, as soon as possible after packaging has been completed, is essential to maintain the product in a condition which is most acceptable to the eventual consumer.

This brief indication of the sequence of processes in ice cream manufacture may provide an appreciation of the possibilities of development within the scope of this particular framework. (Distribution problems will be considered later in this Paper.)

mix processing

Wherever in the world ice cream was being made in the late 1940's, a batch process was used for the mixing operation. The development team appreciated in 1948 that a method was needed for increasing the mix production within the factory space available in order to keep pace with the rapidly expanding business; it being virtually impossible to obtain facilities for building at that time. A study was made of the operation of the existing plant with a view to discovering how its " through-put " could be increased. The first thing noticed was that a large part of the total operating cycle was occupied in filling and emptying the pasteurising vats; for example, in the case of a 400-gallon pasteurising vat, 20 minutes were required to fill it. Heating started during the filling stage but a further 10 minutes were necessary to heat the contents up to the prescribed pasteurising temperature, 10 minutes were required to hold it at that temperature and 20 minutes more to empty it. Thus the total cycle was 60 minutes, over half of which was occupied in unproductive work.

It was obvious that some time could be saved if the ingredients were heated on their way into the vat, but this immediately raised a difficulty, since the plate heaters, which were suitable for heating dairy products on a continuous basis, tended to develop milk " burn-on " if the flow was interrupted at any time, as indeed it would have been as soon as the vat was filled. The time occupied in filling was determined largely by the pumping rate and the time occupied in emptying was determined by the speed of the homogeniser. Altering the size of the vats would not have helped; if smaller vats had been used the proportion of holding time to total time would have been increased and with larger vats the proportion of heating time to total time would have been increased. The only solution was to eliminate the vats altogether or, if this presented insuperable technical difficulties, to dispense with the holding time in order to permit the use of smaller vats which could be filled and emptied more rapidly. This meant, in fact, the changing from a batch process to a continuous process, but a continuous process which provided 10 minutes holding time would have required a tube over 500 feet long to serve each of the homogenisers. It was considered necessary to go over to a high temperature short time method of pasteurisation which had already been established for the milk industry; this method heated milk to a higher temperature, above 162°F, but held it there for a

much shorter time, at least 15 seconds. This projected change immediately presented three difficulties: (i) the high temperature short time method had to be adapted to ice cream usage, which in itself was not too simple since certain physical properties of ice cream mix, particularly the viscosity, differ appreciably from those of milk; (ii) the method of mixing the ingredients had to be modified so as to yield a continuous feed to the new process; (iii) the law had to be changed, since the Ice Cream (Heat Treatment) Regulations of 1947 had not envisaged the use of a high temperature short time process and had prescribed only the conventional batch processes.

It was decided to tackle all three problems simultaneously, trusting to blind faith that all would be solved. In the event, the technical problems were solved first and there was brought into existence a magnificent new and completely automatic mixing and pasteurising plant—not to be used for nearly two years while the various Government authorities studied its operation and considered and reconsidered the wording of the new Regulations.

where to begin

The difficulty, as always, in designing something new was to know where to begin—a figure of 500 gallons per hour was chosen simply because this was the amount of ice cream mix being consumed in a particular section of the factory. It was decided not to depart from the established principle of weighing the ingredients, since at that time no satisfactory method had been evolved for the efficient volumetric measuring of products with varying densities, e g., milk aeration could vary from day to day and hour to hour. It was also decided to make the weighing operation automatic, in the hope that it would be possible to achieve such a consistent product as to obviate the need to standardise every batch. This in turn would reduce the need to accumulate each batch in order to standardise it before use and therefore the total stock of mix and the total space devoted to carrying this mix could be appreciably reduced. The only way in which a continuous flow could be achieved at the speed required, was by the process known as " batch cycling." This involved repeatedly weighing small batches, which were then released through one of two alternative systems, each, so to speak, taking it in turns to maintain the constant flow to the pasteurising plant.

All the ingredients were either liquid when they were received by us, or could be made into a liquid mixture without much difficulty. There was no serious problem in delivering the ingredients into the scale pan and closing the valves when the right weight had been received, but it was necessary to ensure that the ingredients were partially heated and roughly mixed as soon as possible after they had been weighed together, since otherwise the warm liquid fat might solidify in the cold liquid milk. Furthermore, the subsequent homogenising process, of necessity, required that the fat and other ingredients should flow in a mixture roughly in the correct proportions. Some vats were therefore necessary between the weighing plant and the pasteurising plant and it was advisable for these vats to be as small as possible. A disadvantage was that the smaller the vats, the smaller was the batch that was released into them from the weighing plant, and consequently the greater were the number of batches per hour. In the weighing process there was a limit to the pumping speed, since too fast a rate of drop into the weigh-pan gave false readings; also a short delay occurred between the moment the prescribed weight was received in the weigh-pan and the action of the compressed air valve which stopped the flow of the ingredients into the weigh-pan. It was important that the quantity of an ingredient which could flow during this hiatus should be as small as possible, since otherwise there would be a material difference in the total quantity of the ingredients. To take care of this point it was necessary to introduce a trickle feed, which came into operation when three-quarters of the requisite weight was registered by the weighing device. All this meant that there was a certain amount of " dead time " for each batch that was weighed, and that therefore there was a limit to the number of batches which could be weighed per hour; in the end, of course, all these points were resolved and a properly balanced system was designed.

An automatic continuous mixing plant was developed. (Figure 1.)

It was made up of the following:—

(a) An automatic weighing unit connected at the receiving end to a series of vats containing all the ingredients necessary for the mix in liquid form, and at the delivery end to—

(b) two small mixing vats each able to hold the full content of the weighing pan, operating alternately and delivering their respective charges in turn to—

(c) a larger vat termed a " balance " vat which was fitted with a high level electrical control and which fed its contents into—

(d) the preheating section of a high temperature short time plant which heated the mixture to 160°F and delivered through—

(e) a mix homogeniser to—

(f) the second stage of the heating section of the high temperature short time apparatus. The mix was here brought up to a temperature of 175°F, passed through a tube, of such a size as to impose a passage time (and thus a holding time) of 15 secs., and then—

(g) cooled down to 38°F by passing between plates cooled by water at just above freezing point.

Operation (f) was a critical one in relation to efficient pasteurisation and in order to ensure that all mix reached the required temperature of 175°F, there was fitted a flow diversion valve at the point where the mix entered the holding tube. This valve came into action if the mix reaching it was below 175°F and caused the flow to be switched to the balance vat (c).

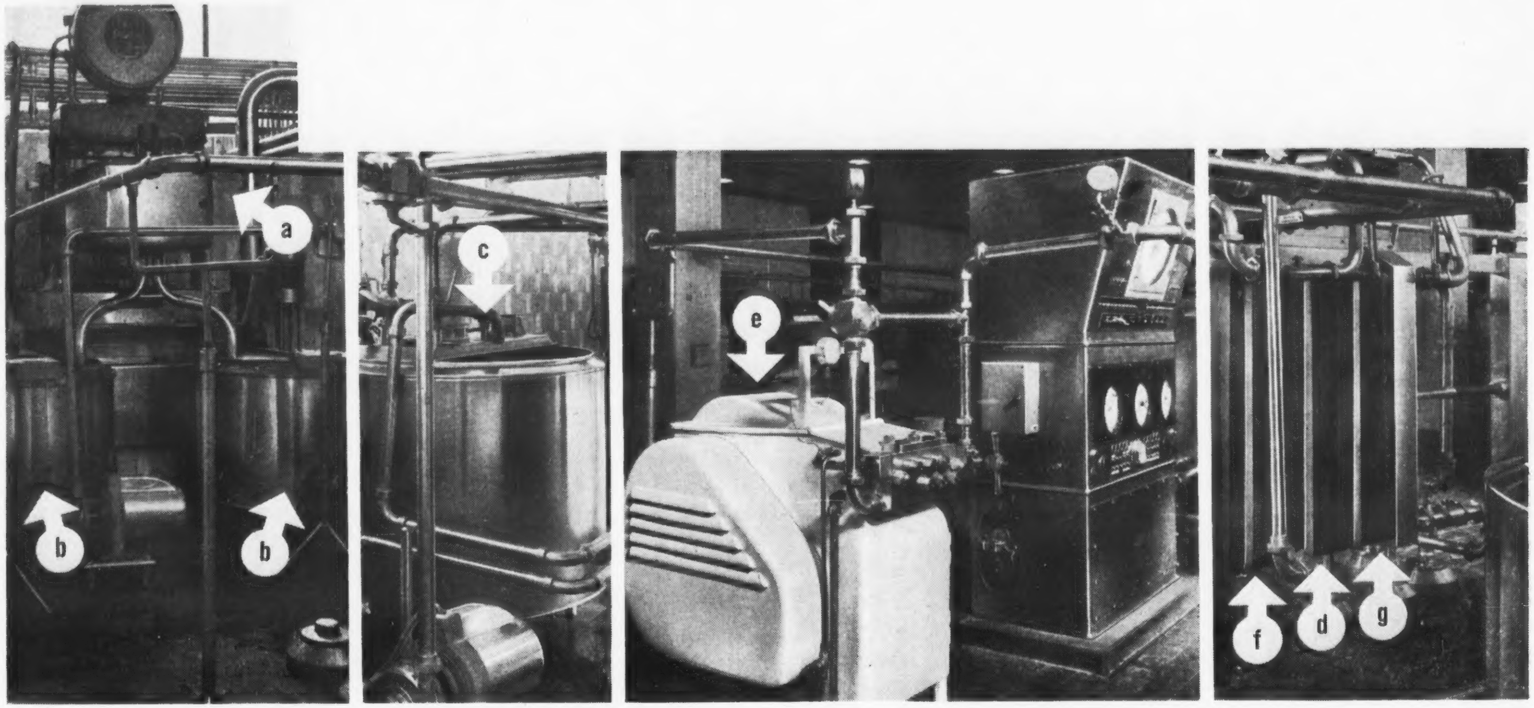

Fig. I. CONTINUOUS MIXING PLANT:

(a) An automatic weighing unit connected at the receiving end to a series of vats containing all the ingredients necessary for the mix in liquid form, and at the delivery end to—

(b) two small mixing vats each able to hold the full content of the weighing pan, operating alternately and delivering their respective charges in turn to—

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(f) the second stage of the heating section of the high temperature short time apparatus. The mix was here brought up to a temperature of 175°F, passed through a tube, of such a size as to impose a passage time (and thus a holding time) of 15 secs., and then—

(g) cooled down to 38°F by passing between plates cooled by water at just above freezing point.

The valve opened up to the normal flow when the temperature reached 175°F.

This development had been completed by 1950, but it was not until 1952 that the new Heat Treatment Regulations were finally approved and we were able to use our continuous mixing plant as planned.

freezing

An understanding of the process of lowering the temperature of ice cream mix until it reaches the condition which is familiar to all as ice cream, needs some information regarding the changes in the structure of the product with the change of state.

The dissolved solids in a good quality ice cream, including sugar, lactose and inorganic and organic salts normal to milk, cause a depression of the freezing-point of water of about 4.5°F; this figure varying, of course, with changes in the dissolved solids content. Ice formation thus begins at around 27.5°F. If the temperature of ice cream mix were allowed (as in the ice tray of a household refrigerator) to drop below this figure under static conditions, ice would continue to form until a wet product was obtained with large ice crystals therein; the latter very noticeable to the teeth and the palate. If the mix is put through a freezing apparatus which causes the mix to be lowered in temperature quickly the ice crystals formed are microscopic in size and the product is smooth to the palate. Furthermore, if in the course of freezing the ice cream is whipped, it will incorporate air, and when eaten, will not be stodgy and heavy, but light and readily consumed. Ice cream direct from a freezer is sold in certain circumstances, but in general the ice cream dealer who serves the ultimate consumer has not the facilities for operating freezers of this kind; it is necessary to prepare the product so that it may be sold direct from a refrigerated cabinet.

For the caterers, confectioners, grocers, cinemas, supermarkets, chain stores and many others who sell ice cream to the public, it is necessary that the product shall be firm, whether it be wrapped or sold by taking portions from bulk contained in a can or carton. This condition is reached in the factory by a hardening process which can be achieved in various ways, of which the following are examples:—

(a) Filling pre-formed containers with ice cream flowing from the freezer and keeping the containers in a room at about —20°F from 6 hours upwards.

(b) Passing the containers, filled as in (a), through a refrigeration chamber or tunnel with moving air at —28°F or lower, for a period of 1 hour or more.

(c) Passing the ice cream in ribbon or block form through a refrigeration chamber or tunnel in which there is an air-blast at —30°F, or lower, for periods which may be as short as 10 minutes.

Needless to say, there are many possible modifications and combinations of these methods.

In studying the possibilities of improving freezing and hardening processes, the development team were convinced that the texture of the final product was a fundamental consideration; that, in fact, it was important that the ice cream should be creamy. Such a condition, it was known, could only be achieved by rapid freezing and hardening. It was clear that the development of plant must follow those systems which gave the lowest temperature at the freezer outlet and the fastest hardening time. In this connection the first development was that of ribbon extrusion. It was felt that this was the best way to achieve rapid transit between the freezer and the hardening chamber.

In the first instance, low temperature ice cream from the freezer (21°F) was obtained by the simple method of reducing the through-put per freezer and ice cream was caused to flow into an extruding unit, which spread the product in ribbons over a width of 32 inches. Impellers, designed to move the ice cream without spoiling its texture, caused the product to flow by way of carefully spaced sections, through separate rectangular nozzles on to a continuous steel band moving through a refrigerated chamber. The ribbons were less than an inch thick and an 11-minute transit time was sufficient to reduce the average temperature of the ice cream to —0°F. According to the width of the final item required, the number of ribbons on the band could be 10, 12 or 14. The ribbons after emerging from the refrigerating chamber were cut, if necessary enrobed in chocolate, and wrapped in paper-lined aluminium foil or other wrapping material suitable for food-stuffs.

factory development

While the work of developing plant for specific products was going on, it was very clear that the Cadby Hall ice cream factory was becoming more and more congested and that it was necessary to plan for considerable expansion. The ice cream factory was not the only one operating in Cadby Hall, and other manufacturing departments were also anxious to develop and take up more space, all within a circumscribed area which could not be increased. Someone had to relinquish space to permit expansion within Cadby Hall, and it was generally accepted that the procedure should be for the ice cream factory to build outside and gradually to move there, to permit other Cadby Hall factories to take over the space vacated by the Ice Cream Department.

For national distribution it was established that a factory built in the "Population Centroid," i.e., the Midlands, was in the position most economically to despatch its goods to every part of the country. The period between 1951–1953 was given to consideration of possible sites in various parts of the country that were reasonably central, but finally in 1953 it was decided to use a comparatively large piece of land already in the possession of the Company and available for light industrial development. It was true that the land was not in the Midlands, but it was in an area with which the Company was very familiar and only separated by a canal from a fully operating multiple factory site where other products of the Company were being manufactured.

The value of the work of the development team was being so well demonstrated, that it was felt that a

similar (and in many respects identical) team should plan the new ice cream factory. The situation that faced this group of people was as follows:

Here was a large acreage of undeveloped land, off the main road, not a single service readily available; somewhere on this space a factory was to be planned and built to accommodate ice cream production. It was to be laid out in such a position that gradual development in stages would be possible. Eventually it was to absorb all Cadby Hall ice cream production and further ice cream expansion and it was to house the most advanced plant that could be foreseen. It was also to be laid out in such a way as to leave the maximum freedom for future developments by other parts of the Company—that is to say as large a portion of the site as possible was to be reserved for " future use."

Forty acres of land were available; the first stage of the new factory was not likely to require more than 1½ acres, or with access roads, despatch yards and engineering services, a total of 5 acres. Thus the planners had almost unlimited scope to use any shape or any approach they liked—and they immediately found that if there was one thing more difficult than planning under severe restrictions as to shape and space, it was planning with no restrictions at all. It was like trying to write poetry without metre or form or even without the need to rhyme or scan.

It was vitally necessary to take some broad decisions which would narrow down the scope within which the subsequent planning was to take place. The position in which " everything was possible " had to be destroyed, since clearly there was no time to examine " everything ".

It was not difficult to decide to site the factory in that part of the 40 acre plot which (*a*) was nearest to the main road (thus minimising the length and cost of internal roads); (*b*) was nearest to the canal bank (minimising the length of pipe which was to supply steam to the factory from the existing boiler house situated on the other side of the canal); (*c*) left as large a part of the total site as possible untouched and unfettered for future development. A notional road plan for the whole site was developed—but only for planning purposes, since future inhabitants of the site would have the last word on the roads serving them.

The real difficulty was to answer the questions raised in connection with the factory itself:—

What shape should it be?
What size should it be?
How many storeys should it have?
What services would it require?
In what direction would it expand?

The last question, the direction of expansion, was critical, since the factory had to be capable of expanding first of all to double its initial size merely to complete the transfer from Cadby Hall, and subsequently by an unlimited amount in order to take care of future growth.

For various reasons it was desirable that goods should flow in a constant direction through the factory and it was essential that they should end up in a cold store. It soon became apparent that there was

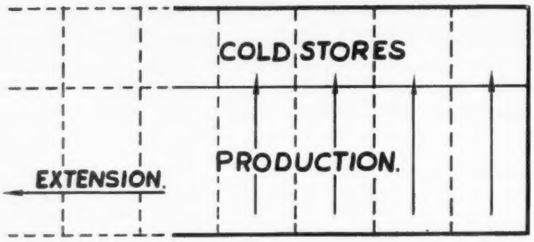


DIAGRAM ILLUSTRATING PRODUCTION FLOW AND FUTURE EXTENSION TO FACTORY

Fig. 2.

in fact only one shape which would permit indefinite expansion, namely, a rectangle in which production flowed across its width (i.e. South to North) the cold stores being along the Northern wall and expansion to take place along the length of the rectangle (i.e. Eastwards or Westwards). Thus all future production lines would be parallel with the initial production lines. (Figure 2.)

A large part of the capital cost of a modern ice cream factory is bound up with the Refrigeration Engine Room, the refrigeration pipe lines and the heavy electrical installations. It was essential that the Engine Room should be able to expand with the factory, so that the additional equipment could be easily coupled up with the existing equipment and a single shift of engineers could look after all the refrigeration plant; this was a safety requirement as much as an economic one. It was clear that there was in fact only one area suitable for the Engine Room, namely, on the long (i.e. South) side of the rectangle opposite the Cold Stores. As the factory was to be built as near the main roads as possible, it followed that expansion could only take place away from them (i.e. Westward).

It remained to decide the width of the factory; this clearly had to be of a sufficient size to accommodate the longest production plant which was likely to be installed. As luck would have it, the line which required the greatest length for its production, namely, Choc Ice, was that which had the most recently installed plant in Cadby Hall and was therefore likely to be the last to be moved to the new factory. A Work Study investigation was carried out on the probable nature of a Choc Ice plant 10 years hence and it was decided that it would require at least 150 ft. It was also known that this was a much greater length than would be required by any other product. Accordingly it was decided to make the width of the factory approximately 150 ft. and to fill up a substantial proportion of the space at either end with administrative services and mixing plants in the early stages; the point being that when the time came to install the Choc Ice plant, it would be possible to dispense with the administrative area and the mixing plant in that particular portion of the factory and make it up elsewhere. The projected layout of the factory was now defined. (Figure 3.)

It will be seen from the diagram that in fact the initial objectives had been met but that two snags had been created in the process:

(*a*) The output of the production lines would have to be taken on elevated conveyors over the intervening cloakrooms etc., to get it to the Cold Stores.

(*b*) Space would have to be found to accommodate raw materials and packing materials and entry into the factory would obviously have to be provided.

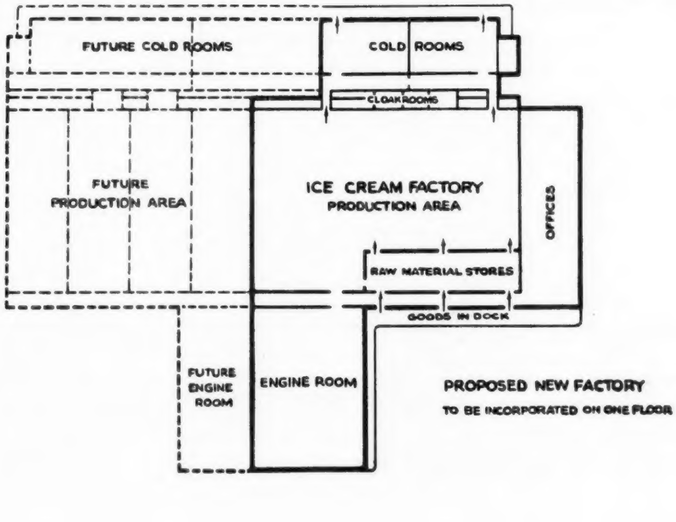
The next requirement to be considered was that of engineering services and in particular that of the ammonia pipe-lines, electrical conduits and hot and cold water pipes which were required to be readily available in virtually all parts of the production lines. The conventional method of taking these services to different parts of an ice cream factory was to suspend horizontal runs of pipes from the ceiling and have " down-drops " to each individual plant as required. The objection to this was that it would create a fantastically complicated network of pipe lines on the ceiling of the factory and, apart from giving an oppressive appearance, it would also make it extremely difficult to keep the ceiling clean. In addition, of course, the pipes themselves could harbour dirt. We therefore considered the introduction of a false ceiling, which did not prove very attractive, since (*a*) the space above the false ceiling had to be made large enough for the engineering staff to be able to get at the various pipes, and (*b*) there would still be a very large number of " down-drops ". A further difficulty was that a false ceiling would effectively block the access of all daylight and would also create a considerable hazard for any services engineer who happened to be there when there was an ammonia leak. In fact planning of the factory proceeded along these lines right up to the production of detailed drawings.

In the course of planning, consideration had repeatedly been given to the possibility of putting the production lines on an upper floor, suspending all the service pipe-lines from the ceiling of the floor beneath and feeding the pipe-lines through holes in the floor. This solved most of the difficulties already mentioned but created another one, namely, that the upper floor would have to be pierced in literally hundreds of places. This was indeed a serious matter, as an inevitable concomitant of an ice cream factory is the lavish use of water and hose pipes for washing down and sterilising. The introduction of an upper floor made it vitally important that it should be waterproofed. It was known from previous experience that it was possible to lay waterproof membranes under a tiled flooring but no one relished the prospect of doing this and then having hundreds of holes pierced through the floor. Eventually it was learned that this particular problem had been met and overcome in America; obviously there was no reason why it should not be overcome elsewhere. A tiled floor laid with falls to the drains was necessary, together with a waterproof membrane between the tiles and the floor.

In each place in which the floor was to be punctured a stainless steel sleeve was inserted; the concrete and the waterproof membrane were lapped up the side of the sleeve above the level of the floor. In this way it was possible to pass ammonia pipes, electrical conduits, compressed air lines and water lines through the floor wherever they were needed without any danger of water on the floor percolating into the framework of the building or on to the equipment below. Cleaning services, such as hot and cold water and chlorine solution, were also passed up through holes in the floor to specially designed hydrants which were set at planned points on the production floor so that all plant could be cleaned and sterilised without difficulty.

In finding the technical solution to one problem (i.e. holes in the floor) another problem was created namely, the need to plan the precise location of every piece of plant so that the service pipe lines feeding that plant could avoid all floor joists. Accordingly the detailed plans which had been prepared for the single storey building with a false ceiling were scrapped and the factory replanned on the two-storey basis. The upper storey was now devoted to the mixing plant, production lines, offices and cloakrooms and the ground floor to the Refrigeration Engine Room, Raw

Fig. 3.



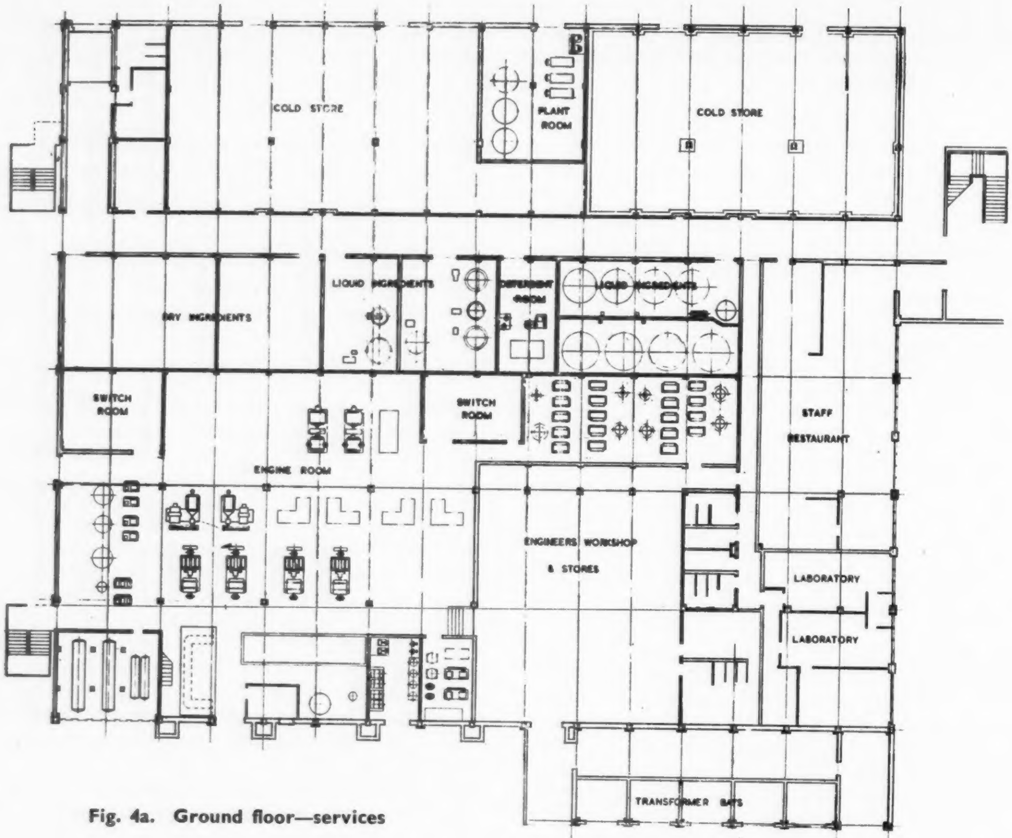


Fig. 4a. Ground floor—services

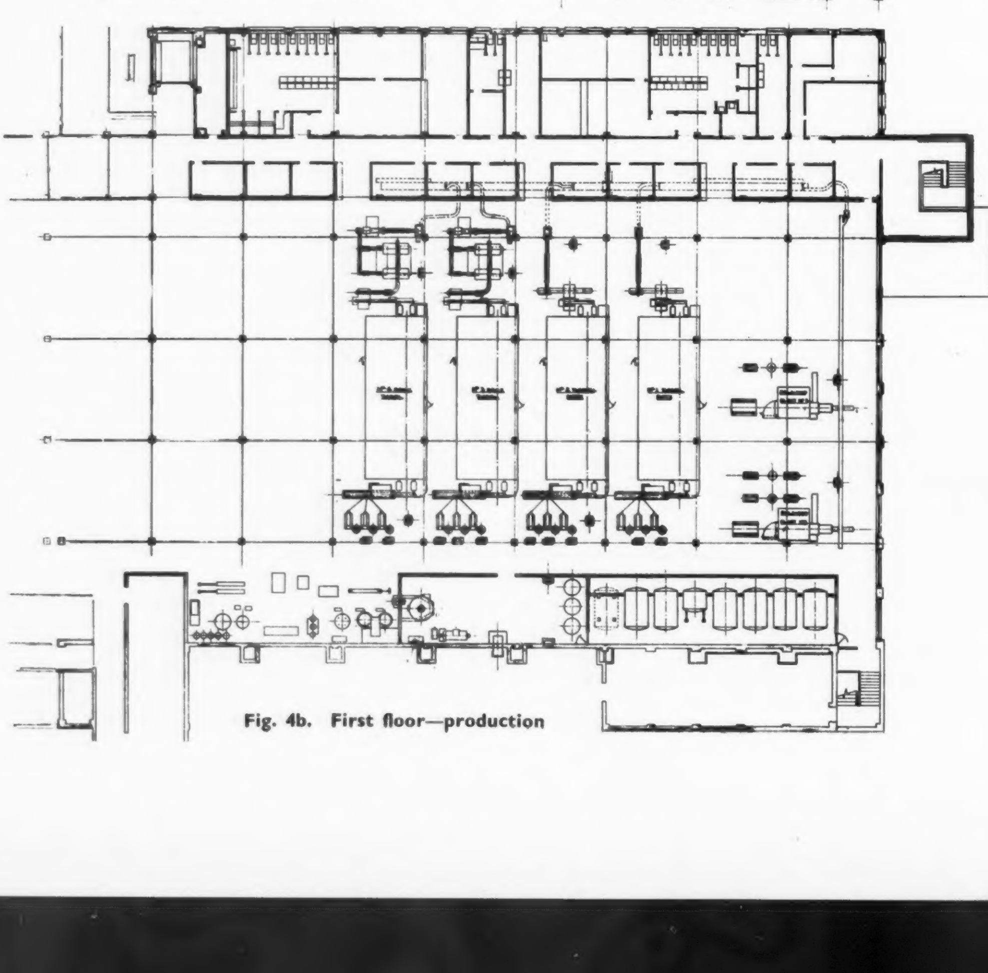


Fig. 4b. First floor—production

Material Stores, Cold Rooms, Staff Restaurant and Laboratory. This arrangement incidentally solved the problem of getting goods from the production lines to the Cold Stores—since it was now possible for them to fall through holes in the floor into chutes which led directly into the Cold Stores.

Long before the decision was taken to build on two storeys, it was necessary to decide the stanchion placings, or rather to decide the most economical layout of plant and then to fit the stanchions to it. A theoretical assessment of the hardening capacity per cubic foot for the tunnels which were being designed for this factory was made—because there was neither the time nor the money available to build pilot plants. It was possible, however, to set up pilot packing operations in order to carry out Work Study on the labour which would be required to pack varied outputs of different products, and in this way it was possible to determine the space which would be required at the delivery ends of the tunnels. The upper capacity of the tunnels was set by the throughput of the standard ice cream freezers. It was necessary to be able to make three-flavour lines (i.e. Neapolitan Ice Cream); it was not to be expected that each tunnel could produce more than the output of three conventional freezers. In practice it was planned to do rather less than this, because of complications which would otherwise ensue at the packing end.

It will be appreciated from this account that in effect the new factory was planned inside out. A shape was decided which would permit orderly and systematic expansion of all components such as production lines, Refrigeration Engine Room, Cold Stores, etc., and, incidentally, permitted some of these elements to expand more rapidly than others, since clearly it would not be necessary to expand all parts of the factory by equal amounts. The overall width of the factory was decided by reference to the longest plant we were likely to put in it and the East to West stanchion spacing by reference to the width of each production line. North to South stanchion spacing was worked out on the basis of cost and was finally decided at 27 foot intervals.

The architects were of course brought in at an early stage and they were in effect asked to design a factory round the technical requirements that had been defined by Work Study. In some ways this was an unusual request and at first sight it might appear not to offer sufficient scope for an architect to deploy his full talents. In practice, the architects found that the limiting conditions were a challenge rather than a restriction and that the problems of building a factory round the plant were well worthy of their ingenuity and skill. Obviously in the course of developing detailed plans various amendments were suggested by the architects and duly accepted; the final result was quite definitely a joint effort. The interesting feature of this operation was, however, that it was started from the production end and finished up with the factory, instead of the other way round. (Figure 4.)

The factors which were to govern the detailed layout had to be decided in order of priority and they are dealt with here individually.

staff amenities

cloakrooms and toilets

Estimates were made for the total number of staff likely to be working in the completed first stage of the project and plans prepared of the most economical and convenient layout of cloakrooms and toilets for men and women. It was agreed that, as the majority of staff would be working on the production floor, these facilities would be most conveniently located at first floor level and that placing them on the North side of the building (the packing end of the tunnels) would have two specific advantages:

(1) the reduced ceiling height required in these areas would enable daylight to enter the packing areas of the production floor at high level, and

(2) they could be separated from the production area by a corridor running East and West, providing a main passage the whole length of the building.

It was apparent at this stage that the number of production bays would determine the length of the administrative area, and, in addition to cloakrooms, it was found possible to include the Manager's Office, a general office and rest rooms for staff and supervision. There was the added advantage, of course, that future expansion of the building Westwards by the addition of more production bays would automatically provide—as well as Engine Room and Cold Room space—the necessary extra cloakroom and office accommodation.

staff restaurant

The remaining matter concerned with staff amenities to be decided was the position and layout of the restaurant.

Two factors largely determined the position—the need to make it as attractive a place as possible and the need to be able to take in food and other commodities without interfering with the main factory operation and without using a lift.

The former point entailed, if possible, a large expanse of window with a pleasant outlook (french windows, for use in fine weather) and examination showed that the East end of the ground floor satisfied the two conditions. The space available after allowing for a main entrance hall and a laboratory, necessitated the restaurant being rather long and narrow: this drawback was overcome, however, by the installation of a striking mosaic mural at one end of the dining room.

incoming goods

The objective was to plan the introduction of raw materials into the factory to follow as far as possible the general conception of continuous processing from raw materials to the finished product. It was appreciated that a bulge in the line of supply of materials was inevitable and some storage would need to be provided to cover contingencies.

The first job was to prepare facts and figures appertaining to the factory rate of consumption of

each item for each product, and to determine the delivery requirements on any one day. From a budgeted production which provided for the manufacture of all lines to meet sales requirements, it was possible to determine the number of van loads and the constitution of the loads for each day's production. It was possible (i) to establish a system for ordering the requirements of the factory; (ii) to provide a method for the timed arrivals of delivery vehicles; (iii) to establish the maximum number of vehicles which would have to arrive about the same time; and (iv) to draw up our plans for an adequate unloading area.

The need for reserve storage revolved around the unpredictable delays in transport, the possibility of a particular item not being immediately available from the supplier, the economic size of deliveries being sometimes in excess of immediate requirements, and the possibility of having to change the production plan at short notice.

From the examination of the problem it was found that storage equivalent to twice the factory's daily consumption of each item would meet all normal contingencies and storage plans were developed on this basis. Idle transport is costly and attention was directed to the need for a quick turn round of vehicles. An area was chosen at the corner of the factory nearest to the entrance to the estate so that the unloading of vehicles would be removed from despatch operations, and the trucking to the stores would be direct and unobstructed. The area was planned into two bays, one for tankers and the other for normal road vehicles, and provision was made for a canopy to cover the area.

At this stage it should be stated that the incoming goods fall into three categories, each requiring its own type of delivery vehicle. They are:

(1) Liquid ingredients.
(2) Dry ingredients.
(3) Packaging material.

While (2) and (3) could be unloaded in the same area, a separate area, although it could be adjacent, was necessary for (1) to provide a pumping installation for each ingredient and trade waste drainage.

The next move was to examine each category of goods and to plan the movement into storage.

liquid ingredients

vegetable oils are delivered in 10-ton tankers; the tanker is constructed with an inner liner which carries the oils, and since the oils have a low melting point, they can be pumped on arrival at the factory. It was necessary to determine the initial storage and then to allocate additional space for further storage to cope with later expansion of the factory. Plans were laid for 2 × 13-ton storage vats initially, with space for two more vats when required. These vats were insulated and heated to keep the oils liquid and connected by pipe-line to the intake pumps and to the mixing plants on the production floor.

sugar syrup is delivered in 13-ton tankers from which it is pumped through pipe-lines into 16-ton storage vats. Two vats were required initially and space was planned for a total of 4 vats to meet expansion. The syrup would be pumped through pipe-lines as required to the mixing plant on the production floor. It was convenient to site the vegetable oils vats and the syrup vats in the same room with provision for a low wall around the oil vats to contain the oil should the vats burst; this being a necessary fire precaution.

dry ingredients

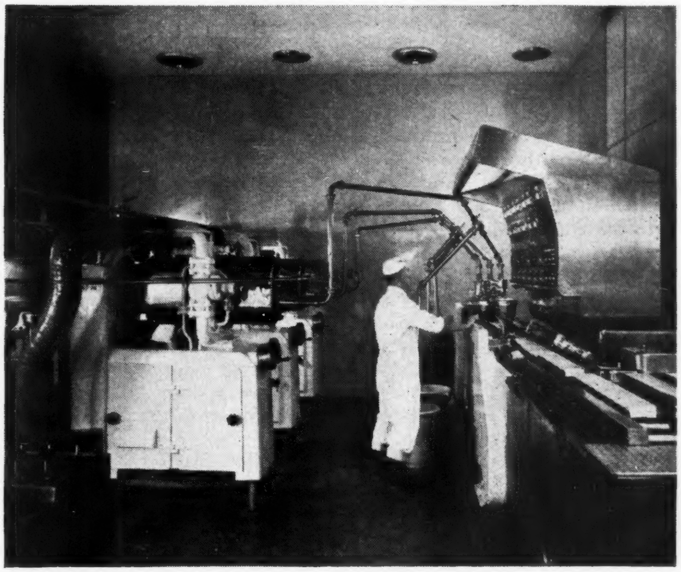
The Company had for many years appreciated the value of the bulk handling of goods and had developed materials handling techniques from the original pallets and hand truck to the most modern mechanical handling methods. Fork lift trucks were used extensively and it was normal practice, therefore, when receiving deliveries from wharves and warehouses to palletise all goods before putting them into the Company's storerooms. Delivery of dry ingredients to the factory would therefore be by road from the central warehouse and we could plan on the basis of all goods being palletised. The time required to unload a vehicle was known from standard data prepared from the experience of similar operations carried out at Cadby Hall, and it was possible to determine that with one fork lift truck, the vehicle could be unloaded in 15 minutes. Taking into account the total volume of goods, including the packaging materials which are described later, time would be available for the same truck to stack the goods in the storeroom.

The design for the continuous process factory called for all ingredients to be supplied to the mixing plant in liquid form. It was therefore necessary to process all dry ingredients and this would be most economically achieved from the materials handling aspect if the storeroom and process rooms were adjacent. These were therefore situated on the ground floor, which allowed for the first floor to be developed as a production area with a " Dairy " finish. Since the pallet loading of each ingredient and the number of pallets required were now known, it was possible to consider the size and shape of the store.

The height of the ground floor (16 ft.) was determined largely by the quantity of ammonia pipes which had to be carried below the ceiling of the Refrigeration Engine Room and this enabled pallets to be stacked three high. The standard fork lift truck required a 10 ft. 6 in. minimum gangway in which to operate. To ensure that all ingredients were readily available, and stacks were used in strict rotation, the store was planned with pallets stowed three deep on both sides of a central gangway.

The next stage was to plan the Process Rooms to deal with milk powder, strawberry puree, flavours, colours, essences and other lesser ingredients. When milk powder is handled and tipped, a small quantity becomes airborne and settles on near-by objects; for this reason it was decided that it should be processed in a separate room. From the production requirements, the type and size of mixing vats, screens, pumps, weighing scales, etc., were determined and miniature cardboard templates to scale were prepared and manipulated until an efficient working layout with

Fig. 5. **The sleeveway process—showing freezers, extrusion apparatus and control panel.**



economy of space was obtained. Apart from the emptying of cases of ingredients and the operating of valves, little extra manual work would be involved, since as far as possible, the unit of delivery would form the basis for the batch, i.e. a given number of cases of milk powder would be emptied into a vat into which a given volume of water would flow. Ingredients added in small quantities would be needed to be weighed for accuracy. Supply of the processed ingredients to the production floor was to be by direct stainless steel pipe-line.

At a later stage, concentrated skimmed milk became available and was supplied as liquid direct from a large manufacturing dairy in 1,500 gallon tankers; the milk being pumped from the tanker through stainless steel pipe-lines to a 2,000 gallon stainless steel storage vat on the mixing section of the production floor.

packaging material

A large proportion of packaging materials was supplied by the Company's Box Making Department and was stacked on pallets at the time of manufacture. Goods received from our other suppliers were palletised on arrival at the central stores and all deliveries to the factory were palletised. As mentioned previously, the unloading of packaging material vehicles was planned to be integrated with the unloading of ingredients, so that the same unloading area would be used and only one team of operators would be needed. It was not desirable to store packaging materials with ingredients, and a separate packaging material store was planned next to the ingredient store on the side furthest from the unloading area. This was planned deliberately, since the packaging material would go from the store to the production floor by lift, and the crossing of incoming goods with packaging material traffic to the production floor was to be avoided. The lift was therefore sited at the end of the building nearest the packaging store, and furthest from the goods-in area.

processing and production

mixing

Reference has already been made to the continuous mix processing plant, in which had been incorporated a weighing process for the ingredients. It had been hoped, over a long period, that it might be possible to overcome the variations in density of certain of the ingredients, so that a continuous volumetric measurement of the ingredients could be used instead of the weighing procedure. Suffice it to say that just before this new factory was ready, such a method had been perfected and with the aid of an integrated series of proportionating pumps, it was possible to follow a predetermined formula irrespective of the speed of production of the combined ingredients. Both weighing and volumetric methods of mixing were built into the Mixing Department of the new factory.

the sleeve way process

There had been designed and manufactured a continuous extrusion unit which formed a cardboard sleeve around extruded ice cream, and folded and sealed and cut off predetermined lengths in one operation. The basic design of this machine had to take into consideration the longest carton that could be economically made on the printing and cutting machines installed at the Company's box factory. The economic length was virtually 20 inches and the first prototype sleeve extrusion machine was designed and made to this specific length. The machine was installed at Cadby Hall and tests initiated. These were very successful and the unit was used for a short period to aid the production of the very popular line known as Zippy. By the time the Bridge Park Plants were being designed, new equipment had been installed in our box factory and the economic length and sleeve was now 27 inches. An embryonic design of a continuous Zippy plant was then sketched, allowing for the use of the new 27 inch long sleeve. An approximate width of the continuous hardening tunnel was arrived at and an overall length of the continuous extrusion machine estimated. The prototype machine was approximately 19 ft. long for handling the 20 in. sleeve and it was necessary to redesign this in order to reduce the length

by something like four to five feet, while allowing for the increased length of the sleeve.

It was necessary to undertake the design of a hardening tunnel capable of handling nearly 720 gallons per hour of maximum output. The requirements were that the product should be reduced in temperature through the freezers from 40°F to approximately 21°F and through the continuous hardening tunnels to an average temperature of —8°F, with the added complication that the product should as near as possible have a uniform temperature throughout the length and cross section of the bar.

It became evident that the sleeves being fed into the tunnel would first of all have to be subjected to a basic hardening process with a subsequent tempering process. Previous experience of continuous hardening was at a maximum capacity of 240 gallons per hour, but no effort had been made to temper continuously. Basic research in conjunction with the Laboratories was necessary to establish the probable times of the various processes. This involved work not only as regards temperature, but also air velocity and the relationship of the flow of the product to the direction of the movement of the air. A design was eventually prepared which appeared to meet the required recommendations regarding air velocity, temperature and direction of flow. The engineering problems which had to be overcome to accomplish this were of no small magnitude. (Figure 5.)

The first two plants installed were built at the Company's engineering works and put under power but not refrigeration. In view of the fact that production was scheduled to start on a specific date it became apparent that various aspects of the design would have to be curtailed, for subsequent development after the plant had gone into operation. Typical features that were postponed were the automatic feeding and tailing of the tunnels, and it might be mentioned here that the tailing devices have now been designed and installed and the feeding devices are now undergoing tests.

An important feature of these plants was the instrumentation. It was necessary to control the refrigeration systems as well as the mechanical systems in all parts of the plant—freezers, sleeve-former, and tunnel. A control panel to accommodate all the instruments and operating switches was required for each plant—in a position convenient to the operators running the plant. A list of the gauges and switches will give some idea of the complexity of each panel:—

3 Start/Stop switches for freezer motors
3 Start/Stop switches for freezer pumps
3 Speed controllers for freezers
3 Resistance gauges for freezers
3 Temperature controllers for freezers
1 Start/Stop switch for sleeve-former
1 Start/Stop switch for tunnel conveyor
1 Speed controller for tunnel conveyor
6 Start/Stop switches for tunnel fans
6 Speed selectors for tunnel fans
1 Temperature controller for hardening section
1 Temperature controller for tempering section

The design of the control panel was particularly troublesome since (*a*) space was limited; (*b*) chlorinated water and rinse water was likely to splash on the panel whenever the plants were sterilised; (*c*) provision had to be made for novel instruments which were themselves still in the design stage, and also for others which were not expected to be developed for several years.

No great difficulty was experienced in the starting up of these tunnels at a capacity of 400 gallons per hour, but the requirements at the packing and cutting end restricted output in the early stages. Upon re-design of the packing site, the tunnels were able to operate continuously at approximately 625 gallons per hour and for a short period one of these plants has operated at something approaching 750 gallons per hour.

Pola Maid

This is a cylindrical piece of ice cream very familiar to consumers of ice cream in this country. Work which had been done in connection with the Zippy plants made it possible to develop new Pola Maid plants which occupied no more floor space than previously, but which gave double the previous output. The only snag was that it was not possible to position double the number of packers around them.

It had been determined from previous Work Study that the carton best suited for packing Pola Maid should be presented in a tray form to be completely closed after packing. This was achieved by designing a carton which, from a flat piece of cardboard, could be formed up at two sides and one end, leaving the flaps at the other end and the top flaps open, thus presenting a tray into which an operator could easily pack the ice cream pieces. The method of packing had been to pick up the two pieces in each hand and pack them into the carton, cut face downwards, until a single layer had been packed. A piece of waxed paper was placed on the layer to cover the exposed top end and the packing and interleaving operations repeated a further three times to complete the packing. The top and end flaps were then closed and the carton sealed with paper tape and set aside to a conveyor. This method required four operators to pack an output of 120 gallons per hour or 116 cartons per hour.

The detailed Work Study of the operation showed that by far the largest element of work was the picking up of four pieces at a time and consideration was given to a means of picking up a greater number at a time. The restriction to picking up more than four at a time by hand was due to the necessity to handle the pieces only where wrapped and not to touch the exposed ends. A close study of the formation of the pieces on the packing table showed that it might be possible with the use of a pronged tool to pick up many pieces in one operation. The idea was to space the prongs to slide into the apertures beneath the pieces at the end of the rows. Several tests were necessary to establish what modifications to the thickness of the prongs and the shape and positioning of a suitable handle were necessary.

Eventually the right type of forked tool was developed and it was designed to pick up four pieces across the forks to coincide with the number of pieces packed across the carton, and four rows deep along

Fig. 6a. (left) Pola Maid packing—old method

Fig. 6b. (below). Pola Maid packing—intermediate stage of improvement

the length of the forks. The operator was now able to tilt the forks over the carton and flick the first four pieces from the forks when the following pieces slid into position at the end of the forks, the operation being repeated until all pieces were packed. The operators took quite readily to this method of packing, since the discomfort of handling the cold pieces was eliminated and they soon became very skilful. The effect was that the amount of work was reduced by more than half and it was possible to plan a packing layout for the proposed new plant with 232 cartons being packed per hour by four packing stations, whereas by the previous method eight stations would have been necessary. As there was only room for four operators, this was very useful. A further benefit gained from the new method was that whereas previously separate operators were required to make up cardboard flats into tray form. this now could also be done by the packer. (Figure 6.)

factory Cold Stores

The need for a factory Cold Store is threefold:

(1) After packaging, the product must be put into cold storage with the minimum of delay and assembling into pallets must take place in a cold room to ensure that the temperature of the product does not rise any more than can be permitted to maintain the quality of the product.

(2) Although the product has a temperature around —6° to —8°F, after packing, the temperature is not uniform throughout the product and if it were, an even lower temperature, —12° to —15°F, would be necessary for ideal storage. The factory Store is therefore required to complete, as it were, the process of hardening.

(3) Factory production can not be transferred to the despatching department until Laboratory clearance has been received in regard to

Fig. 6c. Pola Maid packing—present method

bacteriological condition (48 hours are required and this period is sufficient in which to get the product in the factory Store down to the required temperature). The factory Stores were therefore planned to hold two days' peak production and provision made for the adding of Cold Stores as the factory was extended.

The administration area was needed at an early stage and it would also be required to extend with the factory. Since this also applied to the Cold Stores, an appropriate arrangement was to site the administration area on the upper floor in parallel with the production floor on the North side of the building and then, sufficient space would be provided beneath for building Cold Stores. This placed the stores in a favourable position relative to the packaging area and simple gravity chutes were all that were required to bring the products into the Stores.

The following considerations determined the size of each store and the number of Stores required to begin with.

The potential output of each production plant was known, as also was the position of each chute leading directly from the plants. Of the 8 production bays in the initial factory, 6 were put into use in the first stage and it was determined by calculation of plant output in pallet loads, and by preparing pallet and gangway layout plans, that two Stores, each 4 bays in length with space allocated between for housing refrigeration plant, would cover requirements. In order that the output from the factory could be balanced between the two Stores, a sectional conveyor system was designed to run through the Stores, thus enabling the packages arriving on the conveyor from the chutes to be transferred into either of the Stores by reversing the direction of the conveyor sections. To simplify the handling of the packages into pallets, the conveyor was to be divided across its width to canalise the production from each plant. (The pallets used are referred to in the section dealing with the Despatch Centre and it is only necessary here to say, that the pallet loading is carried out straight from the conveyor and that from this stage until arrival at a local Distribution Depot, the goods remain in the pallet.) The final plan for each Cold Store provided a pallet packing area alongside the conveyor, the packing area also forming a cross gangway with two equidistant gangways leading off at right angles, each running to an airlock leading out to the vehicle yard.

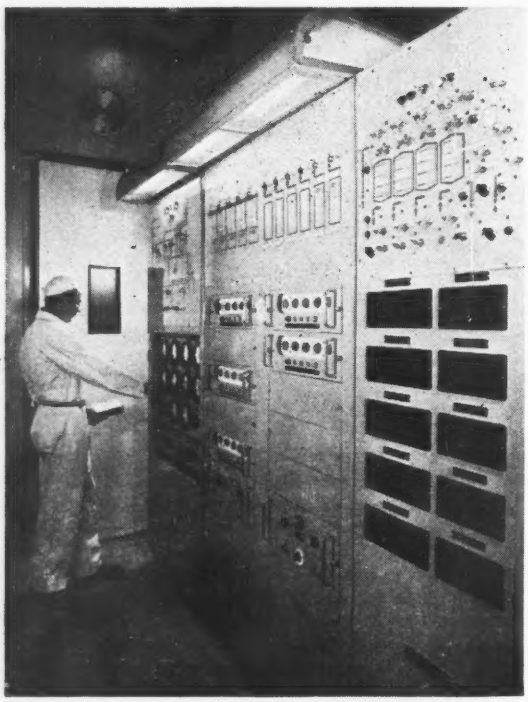


Fig. 7. Part of the central control panel

Each Store was planned to hold 280 pallets stacked two high and arranged so that any stow from a gangway was no greater than 5 pallets deep. The operation of the Stores would be straightforward, the full pallets being stacked into the Store by fork lift truck, removed 2 days later and taken to the Despatch Centre by fork lift truck, empty pallets being brought back on the return journey, thereby maintaining a balance of pallets in the Store.

central control panel

It was considered essential to improve communications between the production floor and the Goods-In and Storage areas, in order to provide remote control operation for the liquid ingredient receiving pumps. It was also necessary to be able to indicate and control at the same time, high and low levels in the storage vats, and also the weights and temperatures of the contents of the vats.

This led to the conception of the central control panel, from which—eventually—every operation on the production plant, every item of information regarding production — weights, temperatures, numbers of finished packages, etc.—could be controlled and recorded.

A scheme was drawn up showing the panel in sections, each with an associated mimic diagram showing the situation controlled by that particular section of the panel. This enabled an operator to make decisions in relation to the starting and stopping of pumps and agitators and the opening and closing of valves.

One such section showed the sugar syrup storage vats on the mimic diagram, with their associated valves and pipe-lines receiving the syrup from tankers and also those delivering from the vats to the continuous mixing plant on the production floor. The switches for the various pumps and valves were set in the diagram in the places corresponding with their geographical location in the plant.

Beneath the mimic diagram were arranged a series of decatron indicators showing the temperatures and weights of the contents of each storage vat.

Similar sections of the control panel dealt with fat storage, milk and mix storage systems and the mix distribution system. (Figure 7.)

recirculation cleaning

As was to be expected, the system just described involved a complexity of pipe-lines and valves, which, by the standard procedures for cleaning and sterilising, would have involved a tremendous amount of work and a great deal of extra cost, in designing a pipe system with removable sanitary fittings and restricted pipe lengths for ease of handling.

Having decided to use a recirculation method to clean and sterilise the pipe-lines " in place," it immediately became possible to install a number of lines permanently—that is, in continuous lengths without any provision for dismantling.

Investigation into the techniques of recirculation and in-place cleaning showed that there were a number of requirements which had to be met in designing and installing the system. For example, the pipes had to be self-draining at certain points and also the number of cross connections required to " complete the circuit " had to be kept to a minimum.

The success of the operation depended on the design and testing of a satisfactory mix valve which could be operated from the control panel by compressed air.

The recirculating pumps had to be arranged to give a certain minimum velocity of cleaning solutions and a certain minimum rate of flow, in order to ensure (a) turbulence in all sections of the system and (b) that the pipe-line was completely filled and kept full. In addition, of course, steps had to be taken to ensure that a minimum temperature was maintained.

When all these requirements had been met, the whole system was linked to an automatic pre-set timing device and incorporated in the central control panel.

general considerations

So that the run of pipe-lines for the general distribution of mix and the incoming liquid ingredients would not look like a Christmas tree, a very careful study was undertaken and isometric projections made of the actual runs of pipes throughout the factory. Pipe supports were designed to fit in properly with the pipe runs, in some instances as many as 14 runs of pipes being carried on cantilevered supports. When the prototype support was designed it became apparent that this support would have to be carried back on the main steelwork; pads to receive these would have to be welded, drilled and tapped in position as the steel work was erected and the subsequent concreting and tiling would have to be done in such a manner that the pipe support could be bolted back on to these pads. Mention has already been made of the problem involved in passing the various services through the production floor and maintaining a waterproof finish around the incoming services, in spite of the fact that such services would be in a state of movement due mainly to thermal expansion and vibration.

The heating and ventilation system was complex, approximately 36 separate installations being accommodated in the space between the production floor ceiling and the roof. Consideration also had to be given to the pattern of lights before deciding the final position of the Air Master mounting in the ceilings.

In the design of equipment for the production of ice cream, careful thought had to be given to the type of material used. Only a limited range of materials is suitable for use in actual contact with the ice cream mix. These mainly consist of stainless steel, nickel alloys and some other non-copper bearing alloys. Heavy protective treatment in the way of galvanising and heavy chromium plating had to be given to those parts of the plant which did not actually come into contact with the product.

despatch

A study of the development of Bridge Park—the name by which the new site is now known—would not be complete without referring to the Despatch Centre, necessary to distribute the products of the factory and indeed of other factories in the ice cream group, to the numerous local Distribution Depots in various parts of the country.

The building and development of the Despatch Centre ran parallel with the factory development.

This Centre was to be more than the normal type of despatch with assembly area and facilities for loading vehicles. As one of three main Distributing Centres feeding goods for fifty depots throughout the country, it was to feed all depots in the Home Counties and the South, to deal with bulk transfer of goods to the other Distribution Centres, one in the Midlands and the other in the North, and to receive from our other ice cream and ice confection factories, products not manufactured at Bridge Park.

It was therefore necessary for the Centre to be capable of dealing with a considerable amount of road traffic and to be equipped with large cold storage rooms, the need for which requires some explanation.

It will be appreciated that the ice cream business is dependent on a number of factors, including of course, the weather. Sales increase considerably when the temperature rises, but to have a plant capable of producing at a high level of output for a few weeks in the year would be most uneconomical. It was necessary to have a plant with a production potential approximating to average expected sales for the Summer months and to build up stocks during March, April and May to balance the difference between production and sales in the following months. This difference represented an enormous amount of ice cream and at Bridge Park alone, it was necessary to plan initial storage of 240,000 gallons, to be increased to 360,000 gallons as soon as possible with even further expansion as the factory was developed. It was because of the urgent need for additional storage of reserve stocks and the necessity to take over the vehicle traffic from Cadby Hall, which was becoming very congested, that a decision was taken to plan for the Despatch Centre to be completed before the factory. The Centre would eventually receive the bulk of its supply from the factory; it was therefore relevant to consider its position in relation to the factory. It would need to grow with the factory and it was logical for the buildings to run parallel with

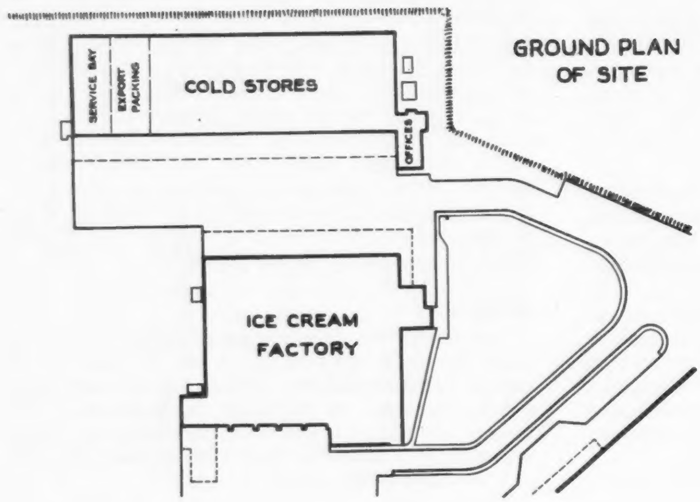


Fig. 8.

each other, but the questions which arose were should it be attached to the factory with the vehicle area on the outside, or should it be separated from the factory by the vehicle area? The latter was decided upon because (a) the factory must hold its production for 48 hours pending bacteriological tests by the Laboratories; (b) stock control in both the factory and despatch would be simpler and more reliable if the stores were separated; (c) the noise from the vehicle and truck operation would be shielded from nearby residential property by the despatch building. Since despatching was in operation for 24 hours of the day during the season, this was an important consideration.

From an examination of the vehicle traffic to operate in the area between the buildings, and by experimenting with templates of the vehicle manipulated on a scale plan, it was possible to determine the distance between the two buildings as 40 yards, which was not an unreasonable distance to transport goods by fork lift truck from the factory stores to the despatch stores. Having established the position of the Despatch Centre and the direction in which it would be developed, it was possible to consider the size of the Stores. Each Store could be 80 ft. deep and this would bring it to the building line at the edge of the estate. Numerous pallet layouts were drawn up to determine the most economical shape and layout for a store in keeping with the necessity for strict rotation of stock. As a result it was decided to build Stores 80 ft. square with one row of stanchions down the centre and that two such Stores would be required in the first stage. Before explaining the layout of the Stores it is necessary to explain the pallet system.

palletising

Several years ago, when the need arose for Distribution Depots throughout the country, an investigation was conducted into the use of pallets to reduce the amount of work in handling goods and to speed up the turn around of vehicles. The need for a pallet which could be loaded direct from the factory output conveyors and be transported through several channels to its ultimate destination was fully realised, but there were factors which could not be overlooked. Among them were such details as the door dimensions of our existing Cold Stores and the internal dimension of the vehicles being run at the time. All the problems were met by a cage type of pallet measuring 3 ft. 3 in. × 3 ft. × 5 ft. 7 in. high, and which could be handled by a fork lift truck; rollers being set on to the floor of the vehicles on which the pallets would run. The pallet was now established and new stores were built to house palletised stocks to an economic layout.

despatch Cold Store layout

Gangways 10 ft. 6 in. in width were required for the standard type of fork lift truck and two gangways were planned for each Store, one centrally between the centre stanchions and one wall, and the other centrally between the stanchions and the opposite wall, each gangway leading to an air lock coming out into the despatch area. Pallets are set four deep on the wall side of the gangways and five deep on the stanchion side of the gangways. It was known at the time of preparing the layout that a special type of fork lift truck (known as a "Reach" truck) was being designed to operate in 7 ft. gangways and provision was made for the eventual use of these trucks with five pallets on each side of the gangway. A depth of stow of five pallets was agreed, so that an easy selection of pallets and rotation of stocks could be made. It was also realised that too deep a stow could result in loss of storage space since a whole line of pallets had to be used before fresh goods could be put into position. The longer the stow, the greater

was the likely loss. The pallets were designed to stack one upon the other and the Stores were planned to receive two pallets high. This gave each Store a capacity of 800 pallets, equivalent to 120,000 gallons of ice cream.

The despatching area was planned at ground level, since with fork lift truck operation, a raised dock to vehicle floor height was no longer necessary. Pallets could be removed from the vehicle quite easily and taken directly into the Stores; similarly, pallets could be removed from the Store, taken to and directly loaded on vehicles. Manual work was to be reduced to a minimum and while 2 to 2½ hours were required in which to load a vehicle with loose packages, a palletised load would take half-an-hour.

Two Storerooms would give a despatching frontage of 160 ft., sufficient for vehicles up to 12 in number to be in position, for unloading and loading and this frontage would be increased for more vehicle parking as further Stores were added. A canopy was planned along the frontage of the Stores, wide enough to cover the despatching area and the rear portion of the vehicles when in position for loading.

The despatch was to be completed and in operation before the factory was ready, and it became necessary for offices and staff amenities appertaining to the Despatch Centre to be incorporated in the building plan for the first stage of the Centre. Advantage was taken of this to incorporate a Drawing Office in the staff building. This made it possible for engineering and electrical draughtsmen employed on designs for the new factory to carry out their work on the site. This proved of inestimable value in easing communications and speeding progress. (Figure 8.)

distribution

depot feeding

Pallets were designed for ease of handling and ease of storage and this fitted in with the plans to increase the number of Distribution Depots throughout the country, since they would be most economical in labour and storage if they were especially designed to accommodate pallets. Large road delivery vehicles were being hand loaded and the ability to modify them to carry pallets influenced the dimensions of the pallet. However, the vehicles were large enough to make it possible to decide on a pallet with a satisfactory pay load. More depots have been built and more suitable vehicles have been obtained and by far the greatest proportion of bulk delivery is by road in pallets; the last vehicles built carrying 14 pallets, approximating to 2,000 gallons of our products.

The vehicle load of 2,000 gallons was 300 gallons less than that of a loose-load vehicle, but a considerable saving was achieved due to the much quicker " turn round " of the palletised vehicle and the saving in labour in loading and unloading. For example, let us consider a delivery to a depot about 30 miles from a Despatch Centre:—

A loose-load vehicle carrying 2,300 gallons, required 2½ hours to load and the same time to unload, while the journey took 1½ hours each way making a cycle time of 8 hours.

A palletised vehicle with 2,000 gallons, required ½ hour to load and also to unload; with the same journey of 1½ hours each way, the cycle time became 4 hours. It will be apparent that the palletised vehicle achieved a delivery of 4,000 gallons in the time it took a loose-load vehicle to deliver 2,300 gallons.

With four men required to load or unload a loose-load vehicle, 20 man-hours were needed for 2,300 gallons, as compared with 2 man-hours with a palletised vehicle which only needed 2 men for the loading or unloading operation. (Figure 9.)

As the number of Depots increased, the delivery system expanded proportionately but this was not good enough. It was found possible to obtain still more effective use of the bulk distribution vehicles.

It must be pointed out that in the ice cream business, peak sales arise only for very few weeks in the year, but distribution must be able promptly to deliver all requirements. Some of the vehicles required for this purpose might have to stand idle for 50 weeks of the year. It was obvious that here was a fruitful field for Work Study.

The first step was to determine the least possible number of vehicles required during peak sales. This was done by calculating the number of journeys to each Depot, using an estimated peak sales figure obtained by statistical means, from sales experience over a number of years. The next step in the preparation of the plan was to determine the time of the round trip from each of the three Despatch Centres to each of the Depots which they fed. Each Despatch Centre with the Depots it served was treated as a closed unit, this requiring three separate plans. The time required for every journey was prepared in consultation with the Transport Department and it was built up by adding together the loading time, travelling time, unloading time, return travelling time and any extra time required by the Traffic Act.

It was necessary to determine the extent to which Depots could receive deliveries at any time of the day or night and where restrictions existed to plan deliveries accordingly. In order to ensure the best utilisation of vehicles, it was necessary to keep them in operation for as many of the hours of the day and night when the Depots could take delivery. It was possible then to calculate the total number of vehicles required at each of the Despatch Centres according to the estimated volume of business and the times during the week when deliveries would be effected. This was done by preparing a process flow chart covering the whole week and split into days, with each day again split into 24 hours. A strip of coloured card was prepared for each journey for each Depot; the length of the strip representing the time required for the round journey, in conformity with the scale of the process chart. By first locating the strips to cover Depots with restricted delivery times, it was possible to fit in more readily the strips representing the journeys to Depots with no delivery restriction. By a little juggling of the strips on the process chart, it was possible to obtain a vehicle operation plan that met all delivery requirements with a high percentage of vehicle utilisation. Where

Fig. 9a. Vehicle loading—loose

vehicle refrigeration recharging was necessary between journeys, this was covered in the plan. Thus plans were prepared for each of the Distribution Centres and the combined results showed the number of vehicles required to meet peak operational conditions.

sales distribution

With the building of Distribution Depots throughout the country, a system of direct delivery to dealers was developed, each Depot being allocated an area and a number of vans to service the dealers within that area. Each van driver was also a salesman and he had his own delivery area.

The vehicle was loaded daily with the saleman's estimate of the volume and variety of goods he could sell and he called at the dealers' premises in his area, to a rough pattern of call frequency, selling wherever possible. His duties also included writing invoices and taking cash. On his return to the Depot, he paid in the cash, which was reconciled with the goods sold. Since the volume of goods loaded to the van were an estimate of sales, a proportion of the goods was almost always returned unsold; the proportion being particularly high when there had been a deterioration in the weather during the day. It also happened that too much of some varieties was carried and an inadequate amount of others. The mileage covered during each journey was also excessive in relation to turnover. It was felt that some of the ineffective calls being made could be eliminated if Work Study techniques were applied and journeys planned in accordance with the volume of business.

It was therefore decided to investigate the problem of sales distribution with a view to planning regular predetermined calls to dealers, and also journeys in which the mileage normally covered was substantially reduced, thus making it possible to add more calls on dealers. To begin with, it was necessary to determine the frequency of call warranted by the business of each dealer, taking into account the amount of refrigerated cabinet storage the dealer had on his premises. One Depot was selected as a pilot, the business and cabinet capacity of each dealer in the Depot delivery area studied and a call frequency allocated to each dealer. Some dealers justified a daily call and others less frequently, the longest

Fig. 9b. Vehicle loading—pallet and forklift truck

interval between calls being three weeks. The final agreed frequencies were: daily, three times weekly, twice weekly, weekly, once every two weeks and once every three weeks.

A record card was prepared for each dealer on which his call frequency was entered and these cards were arranged in such order, that a batch was drawn out daily from the front of the file and after attention returned to the file in a position related to the date of the next call. This ensured that the dealer received his scheduled call on a stated day, and the whole batch of cards was dealt with over a cycle of six weeks. The cards would then be back in their original order and the cycle was recommenced. The planning of the call and the arrangement of the card order could not be achieved without a knowledge of the dealer's location, so concurrently with the examination of call frequency, a study was made of means whereby a planned journey would entail the minimum of van travelling. It was decided to use the National Grid system to identify the dealer's location and to record the National Grid code on the dealer's record card. Studies were made of the time taken to make a call and the time taken in travelling between dealers. From this data it was possible to calculate the amount of time a van journey should take, given the distance to be covered and the number of dealers to be called upon. From a study of the large scale map with the location of dealers marked, it was possible to divide the Depot area into van delivery areas and to evaluate the volume of work daily by reference to the dealers to be visited and the distance to be covered, having mapped out the route to be taken.

Most of the teething troubles associated with the introduction of a complete change of system had been overcome and the plans worked out when petrol rationing was introduced and further economy of travel was essential. Since all the efforts had been bent in this direction when developing journey planning, there was little left to save other than the unsold load. It was necessary to consider ways and means of ensuring that a dealer was only called on when a sale was certain. It was known when a dealer was likely to require a call, but it was also known that it did not necessarily follow that he would make a purchase. The only means of being sure was to ask him and this led to consideration of the practicability and economy of telephone calling with which we had been experimenting for some time previously. The need for petrol rationing was sufficiently strong to warrant a quick decision and the system was launched to cover all dealers with a telephone, those without telephones being given postcards on which to detail an order.

The system worked so well, that it was continued after the removal of petrol restrictions and dealers without telephones were encouraged and helped to have one installed.

Journey planning as originally conceived was not now appropriate in all its aspects, but the basic concept of frequency of call and planning individual journeys was still very necessary. Modifications were made to enable the dealer record cards to be used for deciding when a telephone call was to be made and the journeys to be planned when the required calls were known. To allow sufficient time for the orders to be obtained, the journeys to be planned and the load to be assembled, all dealers were telephoned the day before delivery and all Depots equipped with the telephones and trained operators, the system being known as tele-ordering.

The advantages to the business were that vehicles were loaded with goods that had been ordered and the return of unsold goods to the Depots ceased. All calls upon dealers were effective resulting in more efficient utilisation of vehicles and a resultant lower mileage cost per unit of sale. Needless to say the resultant success of the operation depended upon the co-operation of our dealers, who in the event were now assured that their order would be delivered on the day expected and they would not be bothered unnecessarily.

The essence of Work Study is that it must be dynamic and always at work. It is therefore hoped that nothing that has been said in this Paper gives the impression that there is finality about any of the projects that have been described. Those responsible for them are keenly alive to the possibilities of improvement and to the importance of continued observation.

acknowledgments

This Paper cannot be brought to its conclusion without expressing thanks to the members of the Bridge Park Development Team for their help in its compilation, and also to the Directors of J. Lyons & Company Ltd., for permission to publish details of the work done.

THE REPORT AND DISCUSSION APPEAR OVERLEAF

REPORT AND DISCUSSION

THE 1958 George Bray Memorial Lecture was presented to the Institution on Wednesday, 29th April, 1959, at 6.30 p.m., in the Assembly Hall, Royal Commonwealth Society, Northumberland Avenue, London, W.C.2, and was followed by a discussion. The Chair was occupied by Mr. G. Ronald Pryor, President-Elect.

The **Chairman** said he must first apologise on behalf of Lord Halsbury, who should have been in the Chair but was prevented at almost the last moment.

As members were aware, the purpose of the meeting was to listen to the Sixth George Bray Memorial Lecture. This lecture was established by the Institution in 1952 to honour the memory of George Bray, of Leeds, who had given a lifetime to the interests of production engineers and had been a great stalwart of the Institution, particularly in the Yorkshire Section of which he was at one time President.

His company gave a capital sum of money, the interest on which was devoted to giving the George Bray Lecture every year. They requested that the subject of the lecture should be one not traditionally connected with production engineering as generally understood.

The first Lecture was given in 1953 and was by Sir Harry Pilkington, on glass. The next was on synthetic fibres, by Mr. Robert Douglas, and there was one by Sir Gordon Russell on pride of workmanship. Mr. Stafford Beer spoke on cybernetics and Dr. Yarsley on plastics.

The sixth lecture was to be about ice cream, a subject not traditionally associated with engineering. It was to be given by Mr. Mark Bogod, who had graduated from The Royal College of Science in 1921 and started work in the Laboratories of J. Lyons and Company Limited in 1922.

Mr. Pryor had had the advantage of reading a preprint of the Paper, and he could assure them that it was most fascinating. It could be truly said that it epitomised all that was meant by production engineering.

Mr. Bogod had before him a very selective audience of production engineers. His Paper would, of course, be published in the Journal, where it would reach a much wider public. It certainly deserved even more prominence than this and there could hardly be a better case study for inclusion in a standard text book on production engineering.

(Mr. Bogod then presented the Paper which appears on pages 356 - 375).

Mr. A. L. Stuchbery (*Member of Council*) who opened the discussion, reminded members that in introducing Mr. Bogod the Chairman had mentioned the terms of reference of the George Bray Lecture. The Institution had, of course, taken a good deal of interest in recent years in what some of them called "broadening the base", and certainly in regard to the application of the principles of production engineering to fields with which it was not normally associated. The Paper set out in admirable detail the application of these principles to a manufacture that was about as far from metal cutting and metal forming as one could imagine.

One was accustomed to think of the application of engineering principles to the production of capital goods, motor cars, domestic appliances and so forth as a real contribution to the standard of living. But one was less aware of the value of that contribution to things concerned, should he say, with clothing, food, distribution and the like.

He wondered whether Mr. Bogod could say what was the element of ice cream in the modern standard of living. He imagined it was a specific factor in the cost of living index. He would be interested, as a relatively old man, to know what was the change in value and price to-day as compared with the days of hokey-pokey, which he believed was a penny a lump!

However, there was no doubt that the value as compared with the changes in money values and so on was quite remarkable, and he did not know whether Mr. Bogod could give any indication of the growth in the national consumption of ice cream.

At the beginning of his lecture he had said that the Team's efforts were based on Work Study, defined in its broadest sense to mean the systematic investigation of a situation and an operation. Work Study was often misunderstood. Some people regarded it too much as the application of the stop watch. Mr. Bogod had shown the advantages of really studying a situation in its widest possible sense, and the application of all the other disciplines which could be brought to bear on the manufacturing process which was integrated into one single entity.

Almost in passing, Mr. Bogod remarked that the work required not only inspired individual thinking but also organised thinking. The type of Work Study described indicated the sort of organised thinking, but time and again the Paper showed the element of inspired individual thinking. There was a tendency to be too easily misled as to the value of inspired thinking. One could not do without it in any development which was going to be of real value. It must

Mr. G. Ronald Pryor (left) and Mr. Mark Bogod enjoying each other's company at the reception preceding the Lecture.

be informed by study, but it must be inspired if it was to reach out to something beyond itself. This marriage of inspiration and observation was the trick one scored when one had a really good team of the type to which Mr. Bogod had been referring.

He also referred to the necessity for advancing on all the problems simultaneously, trusting to blind faith that results would be achieved. Mr. Stuchbery did not accept blind faith in this sense, and he suspected Mr. Bogod did not, either. He believed that it had to be thoroughly well informed; if faith was the substance of things hoped for and the evidence of things not seen, then it was not seen except by inspiration. It was the ability to see something beyond what was immediately observed in physical things, and here again he wondered whether Mr. Bogod would agree that thinking beyond the thing immediately seen required a particular type of mind, a man who had frequently to operate in a climate of scepticism; a very lonely man, who could expect little encouragement or sympathy until his schemes were successful.

However, the object of these remarks was to open the discussion and he had had the temerity to make one or two observations which perhaps underlined some of the points in the Paper.

He would like to conclude by asking one question. He knew nothing of the manufacture of this particular commodity, but he knew something of the packaging business and some of the hazards that went with it. In designing a process in the ordinary way, a good deal of thought had to be given to aspects of safety and so forth. He imagined that in this connection the major aspect of safety was factory hygiene and sterility. It would be interesting to know what problems arose in maintaining sterility and, if it was achieved by steaming down the equipment, whether any problem arose at the point at which one had to penetrate into sub-normal temperatures, and also whether any problems arose in regard to sterility in the packaging materials themselves.

One final point: what sort of shelf life was it necessary to provide for?

Mr. Bogod said that ice cream was indeed an element in the cost of living index but he could not say at the moment what part it represented. He would say that the consumption of ice cream was approximately three times more than before the War. The cost of a piece of ice cream the same size as a piece that cost 2d. before the War was now 3d. That only applied, however, to the type of ice cream made with vegetable oils that had become popular in this country. With dairy products the price was about double the prewar price. With which variety a comparison should be made, he was not in a position to say.

He had not realised that anything in the Paper could be put down to blind faith. He would rather call it controlled faith.

Packaging certainly represented a very serious problem in the ice cream industry. It was a bigger problem than in most other industries, for the reason that great care had to be taken to ensure that there was no contamination of the product. This consideration applied right through the operation, wherever ice cream came in contact with surfaces of the plant, as it might well do before it reached the paper wrap or carton. Every such surface had to be of stainless steel and every part of the plant in the immediate neighbourhood must be such that it could be cleaned easily and was readily susceptible to sterilisation. One avoided the use of steam as much as possible, because it tended to distort the delicate fittings in a packaging plant. One used such a medium as chlorine water, which was an effective sterilising medium and the packaging machine had to be so constructed that the chlorine water would not cause corrosion.

Consideration of what was the shelf-life of ice cream was a "long story", because ice cream was a peculiar substance judged on its physical characteristics. It contained, as well as the normal ingredients, air and ice, the content of the latter being dependent upon the temperature of the ice cream. The life of the ice cream so far as bacteria were concerned was almost indefinite when it was below its freezing point. As far as palatability was concerned, its life was comparatively short, especially in a situation where it was subjected to fluctuations in temperature; as it would be, for example, in a dealer's cabinet which had to be opened frequently in order to take out packages, and put them back again. Shelf-life was so dependent on temperature of storage and composition that specific figures could not appropriately be given.

Mr. Matthew Seaman (*Director, British Oxygen Gases Ltd.*) congratulated Mr. Bogod on his exposition of the methods applied in the ice cream industry and on the work his team had done so brilliantly. It might be said that in the George Bray Memorial Lecture the Institution of Production Engineers had its eyes projected on to methods and techniques in other industries, in order to let the light of day in by that process. As a function of the Lecture one should, perhaps, examine how those methods could be applied to other areas of industry.

He would like to contribute a point of view on the methods and the management tools described in the Paper, which Mr. Bogod had used in depth in the ice cream industry and in regard to other projects under the title of Work Study. He had the pleasure of knowing the excellence of the work done by the rest of the Lyons organisation in applying other management tools in this field, and so perhaps it would not be out of the way to mention them.

Going from the depth of Mr. Bogod's study to the width of management and engineering tools as disclosed in the Paper, many people were becoming aware, as a result of the studies and techniques of the last 10 years, that there were four major management tools coming to the fore, and perhaps he might be forgiven if he separated the generalised work study terms used by Mr. Bogod into two separate parts.

The distinction between the more general engineering and production industries and Mr. Bogod's industry, was that the variety and rate of change of the product and the materials were very much higher in the former, and therefore the problem was more complex. But this did not take away from the soundness of the work described and the tools used.

He would look upon the tools used in this exercise in the following way.

First, there was coding and with it standardisation and simplification of policy. This should be deeply studied and well understood and should lay down the treatment for any operation. It was essential for control. Those who had studied the Paper would be well aware that the projects had been maintained under a high degree of control, and this applied to the whole of the exercise.

Three well-known Institution personalities at the reception: (from the left) Mr. G. A. J. Witton, Chairman, London Section; Mr. R. H. S. Turner, Vice-Chairman of Council; and Mr. A. L. Stuchbery, Chairman, South Eastern Region of the Institution.

Work Study, which had been generalised in the Paper, might with advantage be looked at in two parts. One was logical operation analysis and here techniques had advanced. Those concerned with logical control had optimum operation in the whole business, and such techniques could supplant *ad hoc* and illogical modes of management thought. The other was concerned with the disposition of the materials, the men, the communications, the means of production, the means of distribution in the best pattern for the present purpose and the best pattern for the future purpose.

So, there were the three tools of standards and simplification policy with the corresponding coding operations, operation analysis and Work Study to break down the problem. Approaching the matter from these points of view, there were arising now— and Mr. Bogod and his colleagues had been successful in their application — modern data processing techniques which enabled one to have information communicated and collected at lower cost and available for high speed for significant control of operations.

Mr. Bogod's group had, in its operations, used these four tools which would be of concern to the Institution from both the technical and mechanical aspects of various types of operations.

He thought this worth saying because these management tools which had been developing over the past 10 years had not been given the attention they deserved in setting them in logical orders. Further study should be devoted to them and the Paper which looked to wider aspects of the problems offered a suitable opportunity.

He had one loaded question for Mr. Bogod in relation to the more troublesome problems as distinct from a factory with 2,000 varieties of products and raw materials, when one had to deal with a factory of 25,000 varieties of parts and 10,000 raw materials, and bought out goods. The whole required organisation by somewhat the same methods Mr. Bogod had applied to ice cream. The point he was trying to make was that these methods were now being applied to a greater variety and it was a matter of even blinder faith than Mr. Stuchbery had suggested, but one in which the probability of success with determination was high.

It would be interesting to know whether Mr. Bogod thought these methods were applicable when there was greater variety and number, and also a greater rate of change in the products and in the distribution pattern that had to be operated?

Mr. Bogod commented that Mr. Seaman had given a masterly analysis of the procedures represented in the Paper. He had certainly proposed a

difficult question. It had been indicated in the lecture that even in his Company there were a number of parts of the organisation where Work Study failed. He would have thought that the possibility of failure in an organisation where variety was the essence of production and change was frequent, was greater. This kind of operation never caught up with itself and Work Study could not be applied in the same way as it could be on the basis of long runs.

Obviously this was not the last word on the subject, because experience showed that Work Study applied in apparently impossible circumstances did tend eventually to bring out something which might result in improvements; for example, in the reduction of the varieties, "uniformising" them in manageable groups, if he might be allowed to use such a horrible word, simplifying their distribution and other operations which enabled the work to be carried out in a more economical manner. If these were possibilities, Work Study might very well be applied.

Mr. W. G. Marsden (*Managing Director, W. G. Marsden Engineering Ltd.*) remarked that there was a saying that there could be no conversation without reference to the weather. Though it might sound facetious, he mentioned it because he felt sure the throughput was enormous, and even with so much mechanisation it must take a considerable time. On a fine day one could imagine that 10 tons would not go anywhere in the London district. Yet it could quite easily be overdone or underdone, and though it was amusing to talk about, it could not be a very amusing situation to have to meet. It must need fire brigade and newspaper tactics and a terrific forecasting ability, together with faith. It would be interesting if Mr. Bogod could touch on some of the difficulties and on how this quite colossal factor of sudden variation of demand was dealt with.

Mr. Bogod said he thought many people must be wondering how things worked out in practice; 10 tons was a very small quantity. In the summer they got rid of between 40 - 50,000,000 portions a week, and that was a big distribution job. Everybody in the organisation was kept on their toes, and efficiency depended upon a pre-planned arrangement of production, storage, vehicles, depots, salesmen, vanmen and telephonists. Everybody had to be keyed up for the time when the weather was going up to an average of 75°. It was hoped that there would be some of it this year! It needed considerable effort on the part of everybody in the organisation. All he could say was that the staff gave of their best and so far as was humanly possible everybody's demands were satisfied.

Mr. H. T. Lossius (*Work Study Department, I.C.I. Ltd.*) said he would like to make some comments as a representative of an industry which was not normally considered in terms of production engineering, namely, the chemical industry.

Work Study techniques were becoming more and more useful and important in the pre-production field, particularly in the early stages of design of chemical plants. Mr. Bogod had outlined a number of interesting and unusual applications of Work Study; in the pre-manning of plants, in helping to sort out distribution problems, and even in helping to decide what a Choc Ice plant would look like in 10 years' time — no mean order!

It had been found that one good way of tackling a new design problem was to appoint a team, similar to Mr. Bogod's team, two or three years before financial sanction was required for the expansion of a plant. In the last few years a Method Study Engineer was often appointed to the team, either part or full time. He should be young, not too inhibited, and he must not be afraid of making a fool of himself by putting awkward, or apparently foolish, questions, if his contribution was to be valuable. He must certainly be very bright and probably a first-class graduate.

When Work Study critical examination techniques were applied to the basic design data, some very surprising results might occur. Designs for plants which had been established for years and which were thought to be economical and good were found to be capable of considerable improvement, and sometimes large savings in capital expenditure were involved. He would like to know whether Mr. Bogod had had a similar experience and whether this approach was practised in his industry.

There was one final small point. The piping problems Mr. Bogod referred to occurred frequently in a similar way in the chemical industry. Over the last few years piping model techniques had been developed which make most of the conventional drawings unnecessary. This method was particularly useful where piping was difficult and clearances were tight. He would like to know whether Mr. Bogod had tried this technique.

Mr. Bogod said he could best reply to the question whether the approach described so well by Mr. Lossius was applicable, in the vernacular—"And how!". This was precisely the kind of approach which was most important in a development team of any kind — the ability to put oneself outside the normal perspective and think beyond what existed and see the possibilities outside. Therefore he must say that he agreed wholeheartedly.

Models of the proposed factory had been built, but in the laying out of pipe-lines ran into insuperable difficulties mainly because of wide variations in diameters. The rest of the development was held up by this consideration, and the use of the models was abandoned. This was probably wrong. He was not sure. It was one of those difficult things about which one could never be sure whether it was right to spend further time upon it. But he felt sure that in different circumstances it was a good thing to apply the system of model pipe-lines in a three-dimensional problem.

Mr. Hayter (*London*) said that he was associated with the food industry. He had not read the Paper but like many others he had listened enthralled to the

unfolding story, realising how much operational research and know-how had gone into these simple and concise statements.

Three easily assimilable gems emerged for him. The first was the lateral development along the long side. Then there were the under-floor services in the two-floor plan and the cleaning of the plant from the central panel. The work that had been done on distribution and despatch was so comprehensive that some weeks' study would be required before any comment could be made upon it.

He would, however, like to ask about the tall pallet 5 ft. 7 in. high. Had this been designed to enable female labour to pack it?

Lastly, he would like to ask a pertinent question: he hoped it was not impertinent. Would the speaker like to enlarge upon his development team and the efficacy of the team meeting once a week. Did the results in the week justify meeting so frequently?

Mr. Bogod replied that female labour had not been considered in connection with the pallet. It was felt, perhaps wrongly, that women should not work in cold stores; accordingly the possibility of women working with pallets was dismissed. It was not a factor in designing the pallet, which was comparatively a very considerable one in size.

It was found necessary for about three years for the team to meet weekly, omitting those Bank Holidays which usually fall on a Monday. Almost every member of the team was responsible for a subcommittee on some specific problem; it was therefore necessary to keep up-to-date with everybody's results. Needless to say, this was in addition to all the other work for which members of the team were responsible. It was found difficult to make progress in these early stages without frequent meetings. After the first three years, once every fortnight was considered sufficient. But this was because some time had to be found for the main team to deal with development as a whole, as distinct from the new site development.

Mr. B. H. Dyson (*London*) said he would like to add his congratulations to Mr. Bogod for a really excellent Paper. He was delighted to see so many examples of problems met with in all types of engineering for production. They were problems that had to be overcome as a normal course in the food industry.

He ventured to suggest that in the metal-working industry many of them would be considered most difficult, and in some companies they would be regarded as almost impossible. There was, for instance, the handling of materials that were not always self-supporting and only stable in one plane. There were some *people* like that, in industry. But when it came to *products* there was indeed a problem.

Again, there were stores, stock and work in progress that were perishable. Their condition changed under age and temperature, and it was subject, he should imagine, even to aroma contamination.

The third engineering problem was the control of quality. A standard for the measurement of chewiness, creaminess and smoothness was the consistent quality the customer demanded, and the customer always expected the ice cream to be the same to-day, tomorrow and next week. This could cause quite a problem in the engineering industry.

The idea of forming a development group was a first-class one. He felt sure it should be followed in all ranges of industry. But it had made him think again when he had heard Mr. Bogod talk about two or three years. Nonetheless, there were far too many talking committees in industry and far too few working groups.

He did not notice that there was an individual called a production engineer in the group, but possibly that was only an error in name and not in function.

Was the manager or production man who was ultimately going to run the factory included in the group? Was anything done to get away from the fact that when people were put in to run the factory they said, "Of course, if we had had the job of laying it out . . ."?

Forty acres of land were available to Messrs. Lyons, but industry, particularly large-scale industry, had a national as well as an industrial responsibility. How about the national interest, because if industry sprawled all over the land where ultimately was the space to grow the vegetable oils and the sugar syrup? He hoped these were not imported. Why not, in the national interest, a multi-storey factory to conserve this most valuable thing, living space? After all, the modern trend in schools, universities, living accommodation and so on was multi-storey.

He happened to be a member of the Factory Building Research Committee which had issued its first report on multi-storey factories, and he realised, of course, that any type of industrial plant, whatever it was making, could prove of considerable importance in the event of a national emergency. In Sweden the present trend was to construct underground factories and in case of war this was again an industrial and national investment. He believed more thought should be given to putting factories, or at least some part of them, underground.

Mr. Bogod had dealt very fully with the problem of the delivery of raw materials and the despatch of the product. He was indeed pleased to see this, because the engineering industry had for too long looked to production times as floor to floor times, whereas they should really be door to door times, from raw materials suppliers to customer.

Invariably when Mr. Dyson went through a built-up area, he found he was held up because there was a traffic jam. Invariably when he got out to enquire why, he found some suppliers hand-delivering products over the pavement into a retail store. He wondered what was being done to improve material handling so that there was no hold-up in the main road.

There was another product that had to be brought in and taken out of a factory which was very important — the human one, the work people. How about their coming in and going out? Might he ask Mr. Bogod whether the car and motor cycle facilities

In this group at the reception are (from left): Mr. G. Ronald Pryor, President-Elect; Air Vice-Marshal Sir Owen Jones, Immediate Past President, The Institution of Mechanical Engineers; Mr. B. H. Dyson, Chairman, Control of Quality Committee; and Mr. W. F. S. Woodford, Secretary of the Institution.

were underground or on the roof of the factory? Or did they sprawl over the valuable 40 acres?

He had been very impressed with the Paper and it contained a lot of lessons.

Having been acquainted with the measurement of productivity for some time, he thought there was probably a little more about production in it than about actual productivity. He would like to ask a question about factory costs. As everyone was aware, they consisted of material, labour and overheads. In the factories he had been concerned with material represented about 45% of the total factory cost, labour about 10% and overheads about 45%. What was the percentage built up of each of these three factors in the ice cream industry? What was the percentage saving on each compared with the old factory? With the new factory where did the productivity come in? Was productivity improved through reduced material, labour or overhead costs?

In measuring productivity, there were two other quite important factors — productivity per sq. ft. of floor area and productivity per £1,000 capital plant installed. It would be interesting to know what improvements had been made in respect of productivity per sq. ft. of floor area and productivity per £1,000 capital plant between the old and the new Lyons factory.

The **Chairman** remarked that these were questions of which notice ought to be given!

Mr. Bogod, in reply, thanked Mr. Dyson for a most interesting contribution. He very much appreciated the questions asked, because the speaker had obviously studied the Paper thoroughly. If a member of the Institution of Production Engineers was a Production Engineer, then one was a member of the team!

The present manager of the factory was not exactly an unknown but had not been selected three years ago, and it was more a question of the development of people with a view to the final selection of someone who would fit in with the operation. When the selection was finally made, the individual chosen came very much into the discussions on the development of the factory.

He did not know whether Mr. Dyson was connected with an organisation that sold lifts, but the multi-storey factory had always been a headache, as experience at Cadby Hall and elsewhere had shown. How, for example, did one get a conveyor through a lift shaft? Needless to say, the multi-storey building was very well considered, but it was thought of vital importance to get the production lines on one floor.

He might link this with the question referring to productivity. Labour costs had been saved by the modernisation of the plant. Links in the line of management had also been saved by having one floor only to supervise. Unnecessary managerial personnel had been dispensed with and advantage had been taken of the space available to get more productivity per sq. ft. than was possible in Cadby Hall. He could not give figures, but everyone was interested and concerned in productivity, per £ of capital expended, per sq. ft. of floor area and so on. These were extremely important. But if too much time had been given to them, except in broad principle, progress would have been much slower.

Mr. L. Landon Goodman (*British Electrical Development Association*) said he noted the statement on page 363 of the Paper that "A further difficulty was that a false ceiling would effectively block the access of all daylight". He would have thought that the building would have been designed so that there would be no vertical daylight, but possibly side windows, to give perspective and cut out the feeling of claustrophobia. Would it not have been advantageous to insulate the factory roof as far as possible?

Also, Mr. Bogod was no doubt aware of the Building Research Station Report on the high cost of vertical daylight in comparison with electric light, on account of capital and maintenance charges including window cleaning. He was referring to overhead windows, not side windows, and he would have expected artificial lighting to be used to supply most of the illumination required throughout the working period. He would be interested to know about the lighting study made by the team and the lighting level in foot candles or lumens per sq. ft. used.

What was it proposed to do in the future? Presumably some kind of team would be kept in being. It might be a more advanced technological team than that which planned the factory. Was it proposed to put in tape control of production? This might be the next stage after centralised control, possibly with some simple form of computer control.

Had automatic costing been considered? Did raw material prices in ice cream manufacture very to a great extent? He had not noticed any reference to automatic recording of the output of the various production processes. A plant producing tyres was

being exported to Russia, which provided for automatic costing and pricing as the tyres were produced. Possibly that might be the next step. A few words from Mr. Bogod regarding the future would be very stimulating.

Mr. Bogod, said that some members of the team were anxious to avoid daylight within the factory but to put it bluntly they were afraid of upsetting the staff, who were not attuned to looking at walls, — however well they might be decorated, and however well the air was conditioned, but who missed the great outdoors. As a matter of fact, there were many windows looking out on green lawns and that seemed to give considerable satisfaction to staff working in the factory. As he had said, very serious consideration was given to the windowless factory, but they did not have the courage to proceed with the idea.

Mr. Goodman said he meant overhead windows. He agreed with side windows.

Mr. Bogod, continuing, said there were no overhead windows, but for the type of tunnel used, it would have been necessary to increase the size of the building with a false ceiling. It had been possible to take the side of the ceiling away in a sloping direction so that light from the top part of the windows helped to illuminate the factory. This would not have been possible with a false ceiling in the true sense.

He could not give figures for the exact lighting standard. The team went to a lot of trouble to determine the type of lighting by carrying out experiments in Cadby Hall, and the final solution was based on a number of experiments by the electrical staff and the management. There had been considerable experience in dealing with lighting problems at the various restaurants and other places, the results of which members had no doubt seen.

The team had had the use of tape and computers very much in mind, but these were of those things that would come with time. They were still developing the more usual electronic aids, so far as the factory was concerned. The development team on the Bridge Park operation met once a fortnight, because they had still the problem of moving what remained of Cadby Hall over to Bridge Park while considering developments concerned with the plant now in use at Cadby Hall.

Continuously, there were new developments in the ice cream industry and they were very anxious to develop these. There was, therefore, a constant stream of ideas and continuous effort was put forward by the development team which, so far as he could see, would continue far beyond his time. He could not forecast the future in relation to the methods of transference of control to digital computers, but this would undoubtedly come.

Mr. J. V. Connolly (*Director, Sundridge Park Management Centre*) said that at this stage it would be redundant to ask further questions. The Paper was very full and contained excellent and logical descriptions of the processes, and the intention of Mr. Bogod's family that the lecture should depart from traditional production engineering subjects was very well fulfilled.

Indeed, in his experience of many industries, he was coming to the conclusion that the engineering industry—with notable exceptions—needed to learn a great deal about this approach to its problems. Work Study had made more fundamental progress in the chemical industry and in Mr. Bogod's industry than it had in many of the places where it was originally introduced.

It was perfectly true that " motion and time study " was introduced as a tool for large-scale engineering production, i.e., "mass production", and for medium-scale production in batches, but it had often stayed there in a very rudimentary form. There should be great open-mindedness in studying this comprehensive approach which was used in two quite important and separate industries — the chemical industry and the food industry.

Engineers, in his experience, had a tendency to think that because they were technically qualified to solve problems once they were identified and, indeed, were the best people to do so, they could solve the whole situation by engineering intuition, by looking at small parts of the problem. Work Study in its modern manifestation was clearly a more comprehensive technique and perhaps even a more overall management technique when one took Mr. Seaman's extended view of it.

Secondly, production engineers were no exception to the tendency to resist innovation and the advice and suggestions of the non-engineer or someone who was not an expert in a particular field of activity. The chemical industry had hinted that they did not like people to know too much about a project, because experts got bright ideas! If one included in the conception of Work Study the field of operational research, which was a little more exotic in the sense that it dealt with models and mathematical techniques to solve problems previously solved by pragmatic methods, one found the best operational research team was certainly not composed solely of experts in the subject on which the research had to be done. Most of the operational research during the War was done by people like chemists, biologists and anthropologists rather than by soldiers and engineers. This was because they understood statistical processes better than military men.

One of the difficulties in judging the success of certain kinds of engineering projects was that they had a tendency to be unique — " one-off " jobs. This was characteristic of the capital goods industry making large plant and also of the building industry. There was a strong tendency for people engaged in that sort of work to think that because the thing was not going to happen again and again and again, none of this thinking was going to be worth while or applicable to it. But while it was true — and Mr. Bogod made this point very clear — that it was not *always* economical to appoint a development team (or even a single Work Study officer) there were attitudes of mind that could be developed by having Work Study thinking ingrained in the organisation.

(*concluded on page* 397)

Seventh Conference on

"PROBLEMS OF AIRCRAFT PRODUCTION"

Southampton, 16th/17th April, 1959

Theme : " The Aircraft Industry — A National Asset

The Seventh Conference on " Problems of Aircraft Production ", promoted by the Southampton Section of the Institution, took place on 16th - 17th April, 1959, at the University of Southampton (by kind permission of the Vice-Chancellor). This issue of the Journal contains a report of the proceedings in Sessions III and IV. Sessions I and II were reported in the June Journal.

OPENING LUNCHEON

Speakers : The Worshipful the Mayor of Southampton, Alderman R. R. H. HAMMOND, O.B.E., J.P.

Air Chief Marshal SIR CLAUDE PELLY, K.C.B., C.B.E., M.C., A.D.C.

Chairman : J. B. TURNER, M.I.Prod.E., Chairman, Southampton Section.

SESSION I

(The Lord Sempill Paper)

" THE OPERATOR'S POINT OF VIEW "

Speaker : Marshal of the Royal Air Force LORD DOUGLAS OF KIRTLESIDE, G.C.B., M.C., D.F.C., M.Inst.T.

Chairman : The Rt. Hon. THE EARL OF HALSBURY, F.R.I.C., F.Inst.P., M.I.Prod.E., President of the Institution.

SESSION II

" THE INDUSTRY'S POINT OF VIEW "

Speaker : PETER G. MASEFIELD, M.A., F.R.Ae.S., M.Inst.T., F.I.Ae.S., C.I.Mech.E.

Chairman : D. L. WIGGINS, M.I.Prod.E.

SESSION III

" THE IMPACT ON OTHER INDUSTRIES "

Speaker : STANLEY P. WOODLEY, M.B.E., M.I.Prod.E.

Chairman : F. T. WEST, M.B.E., M.I.Prod.E.

SESSION IV

OPEN FORUM — " THE IMPORTANCE OF THE AIRCRAFT INDUSTRY IN THE NATIONAL ECONOMY "

On the platform : LORD DOUGLAS OF KIRTLESIDE; PETER G. MASEFIELD; STANLEY P. WOODLEY; ERIC TURNER, A.C.A.

Chairman : Professor E. J. RICHARDS, M.A., B.Sc., F.R.Ae.S.

SESSION III

THE IMPACT ON OTHER INDUSTRIES

by S. P. WOODLEY, M.B.E., M.I.Prod.E.

Director, Vickers-Armstrongs (Aircraft) Ltd., and General Manager of the Supermarine Works.

IT has been said that an aircraft is a concise expression of accumulated technical wisdom. The technical background of the aircraft industry is combined with energy, imagination and unequalled adaptability so necessary to the assimilation of rapid technical discovery, and for the adjustment to an equally rapid fluctuation in civil and military aircraft requirements. The accumulation of these qualities is such that any review of the contribution made by the aircraft industry to the technological advance of production engineering development in other industries must be considered with the fact well to the fore.

The first powered flight was undertaken a mere half-century ago, since which time the industry has developed until today the earth can be circumnavigated in a matter of hours, and the world's airlines transport some 100,000,000 passengers per year. With the launching of space satellites, space travel is no longer a science fiction subject, but will conceivably be accomplished before the end of the present century. All these facts are the more remarkable when one considers first, that the air is not man's natural element and, secondly, that all this achievement has been compressed into the short space of 50 years.

Despite many mistakes, recessions and setbacks, the industry has continually attempted that which was thought to be impossible, and by application and imagination has surmounted technical difficulties which at first sight appeared to be insoluble. Its short career has been a chequered one, cossetted at some moments in history, ignored and even subjected to repressive action at others, but despite its record of instability and the multiplicity of problems with which it has been beset, or perhaps because of them, the impact of the industry on technological progress has been a fruitful one. From its research into production development have sprung new ideas, know-how and techniques of direct benefit to other industries. In addition, it has been responsible for the creation and development of byproduct industries for which otherwise no requirement would have existed, or which would not have attained their present state of technological advance without the stimulus of the aircraft industry.

Almost all the known sciences are employed in the development of aircraft and because of the effect of rocket development and space travel it is helping to extend the knowledge of astrophysics, astronavigation and of gas plasmas. Aircraft basic research is of almost universal application. The industry's laboratories have participated in the study of kinetic heating, gas flow, heat-resistant materials, light alloys, high strength plastics, high strength steels, titanium, Nimonics, hydraulics, electronics, radar and servo mechanisms. It is therefore not surprising that discoveries and developments have overlapped into other fields to the assistance of other industries.

These benefits are broadly classifiable as follows:

1. Stimulus to overall technical education, scientific progress and technical contribution to allied industries.

2. Wide-range impact on development in the field of general engineering, and in the development of new materials.

3. The development of byproduct industries to meet the peculiar and exacting demands of the aircraft industry.

The industry was amongst the first to establish and finance apprentice schools for the training of future designers, technicians and skilled workers. These schools are second to none in their facilities, their training methods and the quality of the students who graduate from them. Most aircraft companies finance young students attending universities, besides providing large numbers of apprentices with day release facilities to attend technical college courses. The output of trade technicians and skilled tradesmen provided by the educational facilities established by the aircraft industry is a contribution of the utmost value not only to the engineering industry, but to the country as a whole and, judging from the inducements recently offered to men trained in the aircraft industry of this country by other highly advanced communities, to the world at large.

rapid progress

Aircraft design and production absorbs a high intellectual content, and in this connection there are remarkable parallels with nuclear engineering. Both industries are new relative to general engineering, and although nuclear engineering is only some 10 to 12 years old, its rate of progress has been extremely rapid, as was the case with the aircraft industry. In nuclear engineering the study of mass gas flows necessitated, at least for the time being, by the reactor programme based on the gas-cooled graphite moderated principle, utilises the ready-made knowledge of the aerodynamicist, who is well equipped in his technical appreciation of the parallel problems involved.

With the advent of higher aircraft speeds, the aircraft engineer has long been engaged in the investigation of problems of dynamic heating, and its effect on structures is well understood. The temperature gradient across an aircraft structure can adversely affect its strength or alter its aerodynamic shape, and good design can obviate many of the problems associated with this type of heating. The aircraft engineer has thus been acquainted for some long time with problems of heat flow transfer through materials and across interfaces, in the solution of which he has developed advanced methods of mathematical analysis. Allied problems are encountered in the nuclear field, in the transfer of heat from the fuel through its can and through the cooling gap and moderator of a reactor. The mathematical solution evolved by the aircraft engineer to solve his own problems can be applied with little modification. To pursue this parallel theme, the aircraft engineer has for many years been associated with the problems of remote control and servo operation, and these too are problems encountered in reactor design. In the application of electronics and instrumentation, both industries require large numbers of identically trained technicians and the background of the aircraft design engineer has proved to be tailor-made for the nuclear industry.

The training of designers, technicians and production engineers, necessitated by the increasing technical requirements of the aircraft industry, has been accompanied by a striking improvement in the status of the engineer, coupled with a commensurate improvement in salary scales.

Our future, indeed our survival, depends upon the development of new techniques and new industries. Without adequate rewards the qualities that make this development possible will wither — a fact well recognised by the aircraft industry to the benefit of others.

I now come to the second classification of benefits, namely, the impact of engineering techniques on general engineering and the development of new materials and processes. The aircraft industry can be clearly said to have been responsible for the full development of aluminium and its alloys. This valuable structural material is now manufactured in hundreds of thousands of tons annually, and is used in all manner of engineering projects. Had it not been for the requirements of the aircraft industry, it is doubtful whether aluminium would have reached its present state of development. Its use in civil and engineering structures and its commercial and domestic application has been directly stimulated by the initial search for lighter and stronger aircraft structures.

In this connection, aircraft design and manufacture can be described as the resolution of incompatibles, requiring the use of the strongest yet the lightest materials, and the containment of complex assemblies into extremely small spaces. The latter is the science or rather the art of miniaturisation, which is now increasingly important in the coming rocket and space travel age.

metallurgical research

The development of high strength light alloy materials, and high strength steels, are almost entirely due to metallurgical researches initiated by the industry. If titanium, once described as the wonder metal, is ever applied commercially, or in the general engineering sphere, it will be entirely as the result of development in satisfaction of the aircraft industry. This kind of development has been paralleled time and again. A new material has appeared, and because of special characteristics has been applied to the problems associated with aircraft construction leading to an ever widening application in other industries.

Glass cloth and resin laminates, for example, are now used in the manufacture of many commercial items, motor car bodies, lifeboats and small craft, and for containers where strength with minimum weight is required. The development of metal-to-metal resin adhesives and latterly of honey-comb sandwich construction, are finding uses in normal commercial practice. The list has grown long with the years and one does not have to look far in the home or in the commercial field for evidence of the industry's contribution.

It is in the development of machine tools and adaptation that the impact of our industry has been most marked. Until quite recently, the amount of machining necessary in the manufacture of airframes

was comparatively small, but new design philosophies involving the integration of components has expanded the machining processes required until they now occupy a premier position in aircraft construction.

As with many things an effective demand precedes a solution in satisfaction of the demand, and the advent of integration followed this pattern. At first, there were almost no machine tools available which could produce the required complicated sculptured components rapidly and economically. The only machines which could undertake the task to the accuracies required were expensive copy milling machines, but within a short time new machine tools, employing high speed milling heads and copy milling techniques, were devised to meet this relatively new and complex requirement. This in turn has culminated in the growth of a separate industry, providing machinery that has revolutionised the production of piece-parts in light alloy materials.

To pursue this theme a little further, the aircraft industry had for a long time used the woodworking router as a tool for the production of light alloy parts from sheet materials. Utilising this principle the machine tool engineers, by increasing the rigidity of the machines and the power of the cutting heads, created a tool capable of copying complicated sculptured items in light alloy, a process which has proved both rapid and economical of tooling. Only the simplest of templates are required to provide an accuracy well within the requirements of the airframe industry. Even now, these machines are being intensively developed for the machining of high tensile steels.

chemical machining

A new method of metal removal has recently been developed by the aircraft industry which will, without doubt, find many uses in other industries. It is now being investigated as a means of obtaining motor body panels with a weight relief by pocketing methods. This is the principle of machining by chemical erosion. The idea of metal removal by masking the material where it is not required to be removed, and then immersing it in a chemical bath for a period of time dependent upon the depth of etch required, is so simple and economic of labour that it must have a wide future appeal in other industries.

In the manufacture of jet engine components new problems were posed, and specialised requirements arose in connection with the production of turbine and compressor blades and in the manufacture of flame tubes and turbine chambers; requirements that had to be met by the development and adaptation of existing types of machining tools or by invention.

Arising from this need have come a large family of machine tools for the generation or straight machining of turbine blades to difficult aerodynamic forms to extremely close tolerances. Allied to these machines are techniques for finishing and smoothing the blades, together with sophisticated inspection methods and instruments for measuring to close tolerances the twisted and cambered forms involved.

The continuing challenge to meet the aircraft industry's needs, and its ready acceptance of new ideas, is of immense significance, exemplified most recently by the development of electronic tape controlled machining processes. With their distinctive advantages in the production of one-off jobs and in the elimination of tooling necessary to manufacture highly specialised piece-parts, the aircraft industry recognised almost immediately that this technique is tailormade for its requirements, especially as the reduction in the amount of tooling automatically ensures a saving in the lead time necessary for the manufacture of prototype parts, and is considering the application of these techniques to the two and three dimensional control of milling machines, jig borers, the automatic production of templates and two dimensional positioning machines for the drilling of parts without drill jigs. Since the aircraft industry has been one of those most interested in the use of numerical control, it is possible that a result of the recession with which the industry is now faced will be that the rate of development in the employment of this new technique will be drastically reduced.

the stretcher press

The industry uses large numbers of sheet metal components which were at one time produced variously by press and hand methods, but the introduction of processes designed to increase output led to the development of the stretcher press, a type of forming that is now being used in industry, as an economical and ready means of manufacturing difficult double-curvature sheet metal components without the necessity for expensive double-acting press tools. The rubber die press, too, is a unique aircraft industry innovation, which has involved large scale development and tooling methods specially devised for the process which now virtually eliminates post dressing of component parts. Later improvements of the stretcher technique have developed the stretch wrap process, the Verson Wheelon and the hydroform presses, all of them peculiar to the requirements of the aircraft industry, but which have revolutionised the production of sheet metal components to the ultimate advantage of other industries.

There is, in fact, little doubt that the machine tool industry itself has benefited considerably from the problems which have beset the aircraft designer and producer, from their readiness to exploit new avenues of approach, and from the initial machine tool development work that has been undertaken by them. Many inventions and new techniques would have remained undiscovered, undeveloped and unadapted had it not been for the specialised requirements of the aircraft industry and the progressive attitude of those directly concerned with it.

engine development

I would, at this point, draw your attention to the dramatic advances that have taken place in engine

development, and to stress particularly the contribution that has been made by the aircraft engine designers and manufacturers on the vexed question of power/weight ratios. Ever since the first powered aircraft flew, all efforts in connection with engine development have been directed towards greater power for less weight. Early piston engines weighed something around 12 lb. per horse power, but with the use of lighter and stronger materials, with improvements in design and fuels, engines weighing about 1½ lb. per horse power had been developed for service in the last War. The jet engine now achieves 6 lb. of thrust for every 1 lb. of weight and the ram jet will give upwards of 20 lb. of thrust per lb. The turbo jet engine and turbo shaft drive engine are exclusively an aircraft development which has now been extended widely to other industries. As a prime mover the jet engine has been adapted for the propulsion of boats and ships, motor cars and trains; for the driving of pumps and generators and for other industrial power requirements. The ram jet is only in the early stages of development and although it is limited by its requirement for aspiration at supersonic speeds, who would care to predict what future usefulness it may have in other fields?

Design studies and researches into the application of nuclear propulsion for aircraft which are now being considered, will undoubtedly result in lighter and greatly improved shielding techniques, in the more efficient conversion of heat into useful thrust or power, and in the development of small lightweight reactor power units. Ultimate development will be beneficial in reactor design, and I venture to say that the future efficiency of commercial power plants will owe much to the researches conducted in solution of problems peculiar to the aircraft manufacturer, as the knowledge to be gained is of almost universal application.

byproduct industries

I now come to the third of the classifiable benefits, namely, the creation of byproduct industries, and the development of those industries to meet the unique and exacting demands of the aircraft industry.

There are, of course, few industries which can be truly represented by byproducts of aircraft manufacture and employment, but of those industries which have been called upon to meet the innumerable socialised product demands of the aircraft companies, the aircraft industry's influence has been most marked, particularly in the field of radio and electronics. The invention of radar, VHF, the magnetron, the development of radio links, radio direction finding and homing devices have been accompanied by the continuing requirement to fit a quart into a pint pot. The progressive miniaturisation of components is exemplified by the development of the transistor. One can only mention briefly the evergrowing list of electronic devices which have been specially developed, such as automatic flying and homing aids, the radio compass, the radio altimeter, G.C.A., missile guidance systems and astronavigation instrumentation. It would be untrue to claim that the whole of this development was undertaken to meet aircraft demand, but it is certain that development would not have been so rapid without the additional stimulus that this demand has provided.

In the specialised field the tubeless tyre was mainly developed for aircraft requirements, and anti-skid brakes, which are now being adapted for automobile use, were first applied to aircraft landing systems. Powered steering, about which we hear so much in the later generation of motor cars, is of aircraft origin, together with oleo devices and complex hydraulic systems. Hydraulic servo devices now being applied to machine tool control have been derived basically from servo flying systems. In another sphere, the development of high octane fuels owe much to the demands imposed by the high performance aero-engine.

standard of inspection

The aircraft industry has an inspection system without a peer in other industries. The influence of the A.I.D. and A.R.B. has resulted in an inspection whose skill and integrity is the envy of other industries and whose methods have been widely copied.

I have, in the foregoing, endeavoured to illustrate briefly the beneficial effect that the aircraft industry has had upon technical and product development over the past 50 years. This country has an enormous investment in the aircraft industry, which has yielded much in the fields of research and knowledge, in the training of technicians, in the establishment of a vigorous growth which is now withering through lack of support. Without Government support in the field of aircraft development, the general tenor of research and development will decline to the detriment not only of the industry itself, but of all the other fields of commercial enterprise which have benefited over the past years. The acquisition of technical knowledge which may result from any line of development is an intangible which cannot be evaluated in terms of whether the actual aircraft concerned was a complete success or not. Therefore, whilst the present Government policy may be economically desirable, it could also lead to a drastic decline in our aviation export business, as well as possible danger in the military sphere and a general lessening of our technical advance. It might be of interest to note in this connection that our exports of aircraft in 1958 amounted to no less than £154,000,000, with the aircraft industry classified as the second largest exporter of manufactured goods; undeniably, a most solid support and contribution to the national economy.

a costly business

Research and development is a costly business and nowhere more costly than in the aircraft industry, where safety factors and intensive competition, amongst other things to increase speeds and pay loads, must necessarily take precedence. Unless some

national support is forthcoming, these charges must inevitably be reflected in the selling prices of our aircraft, a policy which will place us at a disadvantage with overseas competitors, the development of whose aircraft is considerably assisted by heavily subsidised military aircraft production.

A healthy aircraft industry is vital to our national well-being in times of peace as in emergency, and where other nations are keeping their industries alive in one way or another, the support of the British Government has been withdrawn. We may accept the fact of limited military aircraft manufacture, but we should vigorously resist the withdrawal of national support for the development of new types of aircraft, not only for the aircraft which may result, but also for the benefit of other industries.

The recent enquiry by " Engineering " emphasised that criticism of the aircraft industry for its prodigality with public funds has been common, but it is often overlooked that the industry's participation in Britain's defence at home and overseas has been sought in artificial circumstances, and loaded with exacting military and operational requirements which have excluded the normal habits of commercial enterprise. Thus, some seeming failures and protracted developments entailing Governmental expenditure have not been entirely wasted, as these were all steps along the road to our present state of knowledge. I am certain that the concentration of technical skill, engineering ability and scientific knowledge represented by the aircraft industry, cannot be dissipated except to the country's ultimate disadvantage.

In this realisation there is hardly an aircraft company in the United Kingdom which is not broadening its scope and vigorously seeking other outlets for its energies, and whether the problem is to be overcome by group formation, by diversification or redeployment, it will never be said of the aircraft industry that it tamely lay down and died.

DISCUSSION

In the Chair:
Mr. F. T. West,
M.B.E., M.I.Prod.E.

Mr. H. G. Gregory, M.I.Prod.E. (*Director and General Manager, Fairey Engineering Ltd., Stockport*) opened the discussion by saying that there would be general agreement with the views expressed in the Paper. Mr. Woodley had shown that the serious effects of the Government's curtailment of military orders and aid for development would be felt not only in the field of aircraft construction proper but also in other industries, which would suffer from lack of development and lack of the introduction of new technologies. That was an important point to bring out.

Mr. Woodley was very much engaged in diversification, with which Mr. Gregory also was deeply concerned. It might strike a more cheerful note in dealing with the impact of the aircraft industry on other industries to recall a recent instance in which in one of these industries large numbers of tubes 6 ft. in length had been required. They were subjected to the usual inspection procedure, but afterwards it was found that a number of them on the shop floor were only 5 ft. 9 in. long. Inquiries were made and the inspection department explained that, following aircraft practice, they had cut off 3 in. for test purposes. One had to be careful how far one went in these matters.

The aircraft approach to the design of machine tools had produced something which the machine tool industry had not been able to do before. The defence of that industry was that they had not the money to develop such a machine as the Fairey 3-Dimensional High Speed Contour Milling Machine. and no doubt that was correct, but it confirmed the need for a virile aircraft industry with a sound backing of research and development and the unfortunate effects which would follow from a reduction in orders and finance for that industry, to which Mr. Peter Masefield had referred.

Mr. Masefield had said that the 246,000 present employees of the aircraft industry might be reduced by 100,000 in two years' time. That was a depressing but realistic forecast and a situation which had to be faced. It was essential that those responsible for the formulation of national policy must be made aware of the probable effects of their decisions so far as the aircraft industry was concerned.

Mr. M. Seaman, M.Sc., M.I.Mech.E., F.B.I.M., M.I.Prod.E. (*Director, British Oxygen Gases Ltd.*) suggested that in view of the title of the Paper it might be opportune to deal with a larger question than that of the aircraft industry alone, because of the similarity of the problem in other industries and the fact that the Institution of Production Engineers, as a learned institution, had a job of work to do in this regard.

He thought that it was a common theme, very well put forward by Lord Douglas and Mr. Peter Masefield the previous day, that the problem was one of long-term thinking about a very large sector of British industry, employing large numbers of people, in which it was necessary to think ahead 10 to 15 years and organise to some extent as "Great Britain, Ltd." in that industry. He felt sure that a similar problem to that facing the aircraft industry was facing the shipbuilding industry.

These were industries which had been developed until they were part of the foundation of this country's international position. The country had suffered less than would otherwise have been the case from changes in trade because its transportation manufacturing industries, such as shipbuilding and aviation, had played a great part in the maintenance of its international trade. We seemed to have been caught short at the present time in both aviation and shipbuilding and were very worried about what was going to happen and whether Great Britain was going to lose that leadership which this little island, by virtue of its brains and energy, had deserved to have in the past.

In dealing with the subject introduced by Mr. Woodley, the effect on other industries, it might be appropriate to consider whether or not they understood the mechanism by which they could act nationally, as distinct from the way in which they acted as an industry or as a company. This point had been obscured for 10 years due to the post-war method of financing the aircraft industry. For some time the industry had been carried forward on a national basis, but there had then been a certain revulsion against this — or at least, that to his mind had been the main point of the 1957 White Paper— but there had not been put in its place any mechanism to take care of the long-term problems. It would be worth while for the leaders of this country to work out the precise way which should be followed when an industry had to plan for 10 - 15 years ahead, in close relation to national policy.

It was a difficult problem, but perhaps one of the answers lay in the role of the learned institutions, and here production engineering played an important part, because, as Mr. Woodley had pointed out, a large number of industries depended for their level of attainment on the stimulus given by aviation. It was particularly important to be able to follow a policy which looked after the long-term as against the short-term developments of any private company or associated companies and a particular industry, especially in advanced technical production projects.

He had in mind, for instance, the new Development Committee of the Federation of British Industries. From discussions with the Director-General of the F.B.I., Mr. Seaman understood that the function of that Committee was to look at long-term development aspects of industry and provide a forum where such matters could be thoroughly discussed and plans well laid down. Mr. Masefield had pointed to some of the problems which required hard thinking and definition of policy, and they had to be dealt with by everybody in the country with unremitting vigour.

At the present stage, when a large number of questions had been brought forward, it might be worth while, in terms of the title of the present session, to consider what action should be taken about two major transportation industries, aviation and shipbuilding, which had a great deal in common on the technical production side. So that Mr. Woodley could have a question to answer, Mr. Seaman would put his point in this form: was it not desirable that the learned institutions — which in many cases, and particularly in the case of the Institution of Production Engineers, contained a large number of actual operating executives — should have a precise duty, long-term, in relation to their particular industry or groups of industries, and that it should be their definite policy to study the matter and make clear their views upon it? It might be necessary for those views to go through a body of employers, or a body concerned with the industry at large, and the F.B.I. Development Committee might be used for that purpose. At that point it would join with the trades unions and the National Economic Advisory Council and provide a forum in which these views could be expressed. That was extremely important, because clarity of thought and action had to be developed and pursued.

Such a forum was necessary because it would be the general experience that these matters were looked at by examining various parts and not as a whole, and it would be an advantage to take account not only of a particular industry but of the industries associated with it. Mr. Woodley had raised questions, technical and concerned with policy, in relation to the aviation industry, but, since other industries were concerned which were known to have similar problems, would not it be useful for some machinery of the type suggested to be studied, so that it would be possible to deal, through organisational processes which did not exist in an efficient form at the present time, with the whole long-term situation?

Mr. Woodley replied that the question was one which should be dealt with in the Open Forum which was to follow, in which various phases of the industry would be represented. He felt that if unlimited money were available to be spent nationally it should perhaps be spent in the research field and be fairly widely spread, rather than concentrated in a particular field.

Mr. J. V. Connolly, B.E., F.R.Ae.S., M.I.Prod.E. (*Director, Sundridge Park Management Centre*) said that at the present time there was no doubt that a vast amount of the country's highly skilled scientific and engineering man-power was locked up in aircraft or atomic energy research and projects of that kind. Those who had been present a few days ago at Cranfield would remember that Sir Christopher Hinton, who had been in charge of atomic energy but was now with the Central Electricity Authority, had made the rather curious statement that it might be a good thing to slow down the rate of progress on aircraft and atomic energy and scientific developments generally, in the interests of raising the average

level of technical development and research in those industries which provided the life-blood of this country in the form of exports, and which had suffered from many decades of stagnation in the fields of real technical research and development.

It was clearly not possible, when the country was committed to these two enormous programmes of the development of aircraft and guided missiles on the one hand and of atomic energy on the other, for other industries to find the man-power and recruit the engineers and other technicians necessary, for two reasons: first, they did not exist in the quantities needed to do both jobs, and secondly, the individual preference of the young man at a university or technical college would be to go almost automatically to one of the more glamorous industries for the purpose of expressing himself and working at the fringe of knowledge in these fields. Moreover, since the real difficulty in the other industries was the high degree of competition which they met with in all parts of the world, and since they always had to keep a very close watch on maximum price, they had been very scared of any addition to overheads. They had not been in a position to think in terms of rapid development, because they feared that this would inevitably increase the current price of their products.

It could be something other than an unmitigated disaster to the whole country's economics that it was in a position to contemplate relaxing the volume of intensive research and development on aircraft, and possibly on atomic energy, and getting on with the application of some of the accumulated knowledge and research in a number of other industries. There were whole groups of industries with analogous problems to those which had been solved as part of the normal development of aircraft, and he proposed to refer to one or two in addition to those which had already been mentioned.

The whole building industry was a structural industry and one which was concerned with reliable materials resistant to all sorts of stresses and forces of nature. The amount of change and development and the standard of engineering and technical work in the building industry was quite deplorable. It was an industry which employed 2,000,000 people — about 10 times the number directly employed by the aircraft industry which was completely starved for real technical research and development.

The machine tool industry was, with some exceptions, in the same position. There was in that industry no real high-powered research and development going on, at any rate in the industry at large, of the sort which would be considered normal in the aircraft industry. It was all done in very slowly developing stages, one small change leading to another.

He thought that if it was necessary to face, as Mr. Masefield and common sense generally indicated was the case, a considerable reduction in the volume and number of projects in the aircraft industry, it would be necessary to contemplate — possibly it would have to be done nationally, because the ordinary mechanism of commerce would not do it, except too slowly — a deliberate absorption in other industries of some who were at present members of the aircraft industry. Perhaps they would be among the less brilliant; but, even if they were relatively less brilliant in the aircraft industry, they would have knowledge and experience and aptitudes which would be much in advance of the average in some of the other industries, so that they would be more than usefully employed there. The Conference might do well, therefore, to think in terms of areas in which the " technical horse-power " of the aircraft industry could make a contribution to general economic improvement.

It had been shown that aircraft exports were going up at a faster rate than national exports generally. The reason why the country had not the money to go ahead with aircraft projects was that its general economic position was not so good as it ought to be, and this led to difficulty in exporting other things. The aircraft industry could not be expected to carry the whole country. Every industry which had to export to the world's markets must make a contribution, so that the money was available to do what was needed on an adequate scale. It would be worth while for those attending the Conference to do some constructive thinking on this subject while they had an opportunity to do so together.

Mr. Woodley maintained that to slow down development on aircraft and nuclear power would be national suicide. In his view, it was necessary to go even further than was being done at present. Secondly, instead of transferring some of the less brilliant people from the aircraft industry to other industries they were in fact doing the reverse; they were absorbing some of those other industries within the aircraft industry. Mr. Gregory had mentioned what his company was doing, and that was true also of Mr. Woodley's company and, he thought, of most of the others. With the breadth of outlook and the speed with which aircraft companies worked it would be possible for them to take over industries which were almost dormant and give them the " shot in the arm " which they needed. If it was said that those industries had been starved of technical skill, they were to blame for that, in that they had not shown the necessary initiative but had tended to ride on the backs of those who had.

Shipbuilding had been mentioned, and he could speak with some little authority on that industry. Speaking generally, apart from the use of a little light alloy in the superstructure, shipbuilding had not changed its techniques for many years — the use of welding was only a minor matter — and it was doing today what it had been doing for many years. That was the fault of that industry and not due to the fact that they could not get technicians. They did not pay for them.

Mr. Connolly pointed out that the aircraft industry did not think twice about adding 250 - 300% overheads to their direct cost of production, but other industries, in a competitive situation, had a

much lower ratio. On a very long term view they might be short-sighted, but nobody gave them the money with which to do research and they had to find it from their own profits. An industry might be blamed for not putting more money back into a research pool, but the margins had been of a different order from those of the atomic energy and aircraft industries.

Mr. Woodley said that this was not reflected in some of their balance sheets. He agreed that it was a national problem, but the right method might be for the aircraft industry to take in some of these other industries, and in fact that was being done and done very effectively.

Mr. Connolly remarked that that was only a matter of how it occurred. The differences he envisaged were those of the product and not of company structure.

Mr. Woodley agreed, but said that methods of financing and how it should be done had been mentioned, and it was not possible to divorce the two. It was not true that aircraft companies did not worry about their overheads; that was not so today.

Mr. Connolly replied that it might not be true today, but the traditional figure for overheads in the aircraft industry, due to the need to do research, which was paid for by the customer, had been out of all proportion to that in most other industries. This was not a criticism — merely a fact.

Mr. M. Seaman said that Mr. Masefield had shown that in regard to an industry as a whole, the time-scale of development and the consequent cost presented another order of financial problems and long-term thinking altogether. Mr. Seaman preferred to think of it in this way, that an operating unit would have a certain valid profit-making mechanism, including its overheads, and with a very high technical rate of change it had to think of what was going to happen in the next 10 - 15 years. Unquestionably that affected the development programme, and while much current thinking would put this in relation to sales turnover at 2 - 4% it might have to be of the order of 10 - 15%. This was an important point and had been well put by Mr. Masefield.

Mr. Connolly and Mr. Woodley had both mentioned shipbuilding. Some work had been done on the shipbuilding industry recently in regard to new techniques and, speaking to a group of production engineers, who had to rescue everybody else in the end, he thought that there were two important things which had come out of that. Ships were being built according to technical methods which had been invented in 1650; the basic technical thinking was still the same. Aviation had pioneered, under great stimulus, new technical methods, and those technical methods were hitting them at the present time. Anybody with a knowledge of the shipbuilding industry and the new techniques would agree that there were massive bodies of knowledge derived from aviation which could be transferred to British shipbuilding in particular, and were not being transferred fast enough. That was the root of the problem. It was a matter not of quality, but of sound national thinking.

That had been the point of his original question of why this had happened. The financial conditions had been favourable to aviation and it was glamorous and had done the job, but shipbuilding was a parallel major transportation industry and had not done the job. That should never be allowed to happen again. Clear thinking was necessary on this problem, and he was sure that the basic Papers by Lord Douglas and Mr. Masefield had exposed the problem. He believed that the same modes of thinking and the right mechanism should be used in relation to other industries, and that was of particular importance at the present time.

Mr. Woodley pointed out that one reason why new techniques had not been used in shipbuilding had been restrictive practices by the trades unions. Many shipbuilders knew that there were ways in which they could cut their costs tremendously, but they could not get them adopted. The situation was becoming serious today with the drop in trade. That was why one saw every week that there had been a minor strike in some shipyard over some small matter.

Mr. Seaman said that that was precisely the point. There were, it was well-known, tremendous technical possibilities, but the shipbuilding industry had been affected at its roots by the disease of labour demarcation, and the only way to get rid of that was to expose the whole picture to the trades unions and get their thinking right at an early stage, not wait for the problems to arise.

Mr. R. L. Lickley, B.Sc., D.I.C., M.I.Mech.E., F.R.Ae.S. (*Managing Director, Fairey Aviation, Ltd.*) took advantage of the turn which the discussion had taken to cross swords with Mr. Peter Masefield on the subject of supersonic aircraft, and invited the Conference to consider the implications of this country giving up work in the supersonic field. Mr. Woodley, he said, had pointed out the impact of the aircraft industry on other industries. It had made this impact because it had always striven to get further ahead faster than anybody else. To give up that attitude would be to become involved in a number of difficulties, and in national difficulties, not merely industrial difficulties.

The shipbuilding industry of this country had, not so very long ago, led the world in techniques and in advanced thinking. He suggested that its present position might well be due to the fact that it had become convinced that it was too difficult and too expensive or too long-term, or that the overheads would be too great, to go any further, with the result that the Japanese, the Germans and the Americans were all striding ahead in a field in which this country had once firmly held the leadership. If

this country gave up the supersonic aeroplane and advanced research in aviation, the British aircraft industry might well become producers of rather uneconomic, rather uninspired freight aircraft, which might do their job well, but the result would be a steady lowering of the whole technological level of the country.

Mr. Woodley had emphasised the education which the aircraft industry had given and encouraged throughout the country. The aircraft industry was one of the two biggest users of technological man-power in the country. There was a national programme for expanding training in technology, but where were the people who had been so trained to go? They would not go to other industries which had not yet been conditioned to take trained man-power. It was only within the last few years that the building industry had realised that the quickest way to lift material from the ground to 10 floors up was by a light tower crane, and even then it had to buy the first ones from Germany. To cut down the technological man-power in the aircraft industry and the work that it did would be to reduce the technological standard of Great Britain.

The question of entering the supersonic field should therefore be considered very seriously. It might be found that there was not enough money available to do everything, but it might equally well be found that if the things which involved technological prestige were not done the whole nation would suffer seriously, and it might not be possible to sell the second-line devices. That would go far beyond aircraft, because the world-wide reputation of the people who built the front-line devices reflected, as Mr. Woodley pointed out, on all the other things that were done. That was not a matter of finance or technique but of prestige. The prestige value of doing something better than anybody else was of tremendous importance.

Mr. Woodley endorsed everything that Mr. Lickley had said, which represented exactly his own views on the problem. In his opinion, if the country had only a limited amount of money to spend, it should be spent on advanced research on a fairly broad basis. They should not try necessarily to make the best something or other, but should spread their resources so that all fields of technology received an impetus from that sort of expenditure.

Mr. E. D. Keen, B.Sc., F.R.Ae.S., A.F.I.Ae.S. (*Executive Director, Sir W. G. Armstrong Whitworth Aircraft Ltd.*) said that at a meeting of production engineers he was astonished to find a feeling that the aircraft industry should be turned into a research industry. He thought that the main preoccupation of the British aircraft industry was to get the shops busy on orders. There had been a good deal of dangerous talk that morning. There had been suggestions for getting on with research, but the real point there was that one did not do research unless one had an end product. Mr. Lickley was right in suggesting that work should be done on supersonic aircraft because it would provide a pattern for the research which had to be done. It was generally admitted that the content of the advanced aircraft of the future would be rather more research and rather less production, but at the same time they could not contemplate the aircraft industry sinking to the level of a general research organisation. If that were to happen, then with no particular objective in mind they would not really know what research to do.

Mr. Woodley pointed out that everything had to have a beginning and suggested that without research there would be no need for production engineers in the aircraft industry, because there would not be any industry. That had been the background to the Conference this year. He thought that Mr. Keen had made two mistakes. One was in talking about " sinking to the level " of research. They had to look up to research, and it was not possible to dissociate the production engineer from research. Production on a big scale was simple; what was difficult, and where the production engineer really came into his own, was the economic manufacture of small quantities. In the aircraft field they were going to be faced with that in this country for all time, and their future would depend largely on the sale of brains and capital goods. They were not going to have big production except perhaps in a limited field for some form of light aeroplane. He did not think, therefore, that the Conference was wasting its time in discussing research, because research was essential, and from it would spring the problems which production engineers had to solve, which would affect other fields than aircraft.

Mr. Keen said that Mr. Woodley had misunderstood his remarks. The point he had tried to make was that it was necessary to have something on which to hang the research.

Mr. Woodley agreed that aimless research was not at all inspiring, except perhaps to a very limited number of people; but, as Mr. Lickley had said, if the end result was a supersonic air liner, a prestige aeroplane, it had many residual benefits. When the *Queens* were built they had been regarded as uneconomic and had been built for reasons of prestige and to combat unemployment. The country might be reaching that situation once again in the near future, so that it would be wrong at the present stage to say that we could not afford to build a supersonic air liner and that it would not pay its way. Perhaps it would not, but a great deal would be learned from it and conditions might change. Many brilliant people had made forecasts 10 years ago which had been proved completely wrong today.

A member of the Conference referred to what he described as the apparent paradox that, while the aircraft industry sought to encourage orders for items not connected with aircraft, when giving quotations for certain items it quoted overheads two or three times as great as would be quoted by normal commercial firms. That had been his experience in asking

his friends in the industry for quotations. Was it because they were his friends that they quoted three times as much as other people, or because their costing was based on aircraft experience?

Mr. Woodley replied that when a commercial article was produced in an aircraft factory there had to be differential overheads. If he were asked to quote for something in that way, he would charge an overhead considerably lower than he would charge the Ministry of Supply for their work. If someone wanted his firm to supply, for instance, a piece of electronic equipment, they should not be asked to pay for the use of his airfield or for expenditure on wind tunnels, and such items must be removed from the overhead content which was included in the price. He did not think that the speaker had ever asked him to quote for anything, but it might be that some other firms had taken their standard overhead rate and quoted the normal aircraft rate, which he agreed was higher than that elsewhere. There must be differential overheads.

Replying to a further suggestion that a big firm, if asked for something small, might feel that it was too much trouble, he said that the aircraft industry was looking for work, however small it might be.

Mr. Peter Masefield, M.A., F.R.Ae.S., M.Inst.T., F.I.Ae.S., C.I.Mech.E. (*Managing Director, Bristol Aircraft Ltd.*) said that the overheads problem lay at the root of the difficulties which aircraft firms encountered in getting the diversification work which they knew that they needed. If they had to drop 100,000 people from aircraft work in the next two years their task would be to employ those people on other work, and the question of overheads was at the root of the problem. They might have to get their friends in the Ministry of Supply to think again about the way in which overheads were treated.

It was true that the nature of the work which they did on advanced aircraft projects led to a high overhead; there was a great deal of design, development and wind tunnel work, and so on, which was expensive and inevitable. If a firm went to the Ministry of Supply and said: "We are now going to diversify a bit, and we want to quote someone for direct man-hours on something simple which does not need to carry this design and development overhead" the Ministry would reply: "We are delighted to hear it, but if you are going to put 5,000 man-hours into this work we shall knock off from the average overheads which we are paying on the whole of your work the overheads relating to those 5,000 man-hours." That meant that the aircraft firm had to pay those costs themselves or pass them on to their friends who gave the orders.

He believed that the Ministry of Supply had to take a different view on this matter, and he thought that they were going to do so and would realise that aircraft firms must, for work of this kind, quote a competitive price; but the difficult financial problem imposed on them by the contractual arrangements with the Ministry of Supply was often not understood by everybody, even in the firms themselves. He complained about it a good deal in his own firm, and he hoped that as a result the kicks were going back to the Ministry of Supply and would lead to more realistic thinking by the Ministry on the subject; otherwise the aircraft firms would not get this other work.

The problem of the supersonic aeroplane seemed to loom too large in some of the remarks which had been made. The supersonic transport aeroplane was a glamorous project which was the fashion at the moment, but it was not the be-all and end-all. A decision had to be taken quickly, and it might be right to go into it for a variety of reasons, including prestige and the fact that a great deal might be learned from it, if the money was available . If they did go into it, they must do so at the right speed, a competitive speed, and at the right moment, and not produce an aeroplane which they could not sell. It was no use spending time and money in producing a supersonic aeroplane which never got beyond the prototype stage.

He had suggested that M:3 was about the right speed, and that anything slower would not be saleable, so that the first question to be decided was whether or not they could produce an aeroplane technically for that speed. To that they would all like to answer: "Yes. We know the problems." If it could be done technically, the next question was whether or not the country could afford to do it. It was going to cost £300,000,000 to get real production going, and it would be silly to pretend that it could be done for less. A decision had to be taken, therefore, on whether the country could afford to do it or not. If the answer to both those questions was "Yes," they had then to decide, as production engineers, whether or not the project was going to be worth while anyway. He had suggested that the number wanted would be about 10, and they would be very lucky to get orders for more than 10 aeroplanes, which would cost about £30,000,000 each. They should not delude themselves by thinking that the cost would be less than that. It would then be for the air lines to decide whether or not it would be worth while to incur that cost for operation at fares at which they could sell the seats.

If it could be done there would be great prestige in it, and a great deal could be learned from it, but that was the basis which should be adopted in thinking about it, and it ought to be considered by a high-level group of people who would take into account all the national aspects. They ought not to feel, however, that if the answer to all those questions was "No" they would be out of business, because this represented only a small part of their task. In his view, the big transport business in the short range lay in a Viscount/Convair replacement. From the market research which had been done, he believed that if they could get into this business of a Viscount/Convair replacement, in which the Americans were not at the moment engaged, they could sell 500 - 600

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OPEN FORUM

"THE IMPORTANCE OF THE AIRCRAFT INDUSTRY IN THE NATIONAL ECONOMY"

On the Platform:
Lord Douglas of Kirtleside ; Peter G. Masefield ;
Stanley P. Woodley; Eric Turner, A.C.A.

In the Chair:
Professor E. J. Richards, M.A., B.Sc., F.R.Ae.S.

The **Chairman:** I should like to welcome to this meeting Lady Douglas and Lady Walmsley. I do not need to introduce the members of the panel. I have taken part in many "Any Questions" panels, but never before in such a glamorous one as this. The only member of it who has not given a Paper to the Conference is Eric Turner, who is Chairman and Managing Director of the Blackburn Company. That company has shot up since he took that position.

Since I, on behalf of the University, have not yet welcomed you all, I should like to say how pleased we are to see you here again.

The first question which I have to put to the panel is a double one. Mr. Hollis asks :-

> *It has been said that the ratio of the cost of raw material imports to the export selling price of aircraft is far higher than for any other product. Has this been fully appreciated in assessing the value of the industry to the national economy?*

I shall couple with that another question :-

> *Mr. Masefield quoted a figure of £14 per lb. of aircraft. Since this implies an extremely efficient use of our highest class of labour, what type of industry do the panel suggest could replace it if the aircraft industry were to collapse?*

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in the world today, because that was just the class of aeroplane for which the world was looking. Unfortunately, however, neither B.O.A.C. nor B.E.A. were looking for it at the moment, and so the big problem was how to get into this field.

They had to make sure that they were looking at the whole spectrum, and choose limited objectives which they should go flat out to achieve. If they went flat out, with all the knowledge and skills at their command, they would get the business. They ought not, however, to do research for the sake of research. Mr. Woodley had made that point. If they did research, let it be with the objective of producing something at the end of it. That was what they had to look for to safeguard the employment of 100,000 people in the next two years.

Mr. Woodley asked leave to say a few kind words about the Ministry of Supply. On the question of overheads, he had found them to be fairly sympathetic. After all, if the aircraft industry did not get other work to do they would have to sack a great many people, their overheads would be higher, and the Ministry would have to pay more for development work. The mere fact that the industry was able to bring in other work would have the effect of reducing the overheads to development work for the Ministry.

Mr. E. Turner, A.C.A. (*Chairman and Managing Director, Blackburn & General Aircraft Ltd.*) said he had been much encouraged to find from the discussion that production engineers took an interest in cost; but, to end on a lighter note, he would like to tell those members of the Institution who were employed by companies which were run by engineers that the companies run by accountants had established differential overheads at least 13 years ago.

The Conference then adjourned for a short time, after which the fourth and final session was held.

Mr. Masefield: I think that the first of these two questions is the wrong way round. Raw materials are a low part of the total cost of aircraft, about 15%, although they are very expensive in these days and becoming more so. Beryllium, which is the latest fashionable material for supersonic aircraft, costs about £300 an ounce, and it might be necessary to use a ton or two in quite a small aircraft. It is also almost unworkable, and highly toxic when worked! The fact is that at present most of the money goes in paying not for materials but for brains, because even brains have to live.

If, therefore, we are thinking of any other activity for this industry, we want to find something which uses a large amount of brain-power and a relatively small amount of material. A further point is that the airframe side of the aircraft industry is largely assembly work, putting bits together, and therefore some other work which consists in putting bits together should be sought. I do not believe, however, that the aircraft industry is going to collapse. We are going to do many other things as well, such as electronics, but we are still going to build some aeroplanes, and they are still going to be expensive; £14 per lb. of aircraft is the sort of figure today, compared with £1 per lb. 30 years ago, and I do not suppose that we have seen the end of the rise. New techniques may bring the cost down, and I believe that the use of more plastic materials will in the end make production cheaper, though the material itself tends to be more expensive.

Mr. Woodley : The first question probably means that because we use light alloys we have to buy the bulk of our raw materials from abroad.

In reply to the second question, the other field which uses the greatest proportion of brain and technique and design skill is the nuclear field. It has been found from experience that there is need for a very big design organisation to cope with that sort of work, and equally there is a tremendous amount of assembly work in it, so that probably that field more closely resembles the aircraft industry than any other.

The **Chairman:** We now have a question from the body of the hall.

> *It would seem that the production engineer of today has increasing use for fundamental and applied research on topics relating to metal cutting, plasticity, fluid mechanics, metallurgy and electronics. His collaboration is needed for the statement of the problems concerning manufacture and for his ability to apply the results to machine tools, plant and equipment which will yield higher productivity. Will the panel please comment?*

Mr. Masefield: The answer is Yes.

Mr. Turner: I agree.

Mr. Woodley: The research referred to is carried out for other reasons also; for example, ultrasonics is now applied to metal cutting. I agree that there must be more fundamental research, which in many ways will be linked to research for some other purpose. In the electronics field, for example, we take the results of other research and apply them. If the question is whether we think that there should be continuous research in the production engineering field the answer is certainly Yes, and to a greater extent than in the past.

The **Chairman:** We will pass to the next question:-

> *In the Papers no mention is made of the discontinuity of development arising from the Comet disasters. If these had not occurred, what would be our position in aviation today?*

I think the questioner is implying that if the *Comet* disasters had not occurred we should have a much bigger share of the export market.

Lord Douglas: The thought behind the question is absolutely correct. The *Comet* disasters were a tragedy from the point of view of the aircraft industry, in that undoubtedly many more *Comets* would have been sold if the first had been a technical success than the number of *Comet* 4*s* which have been sold, these having come rather late. At one time it looked as though we were leading the world in jet and turbo-prop transport, but we seem to be dropping behind a little in the race for jet transport. That would not have happened, I think, if the original *Comet* had not failed.

Mr. Turner: I agree with Lord Douglas that but for the disasters we should have sold more *Comets* and had a greater backlog of orders, but I feel that the competition which we are facing now from the Boeing 707 and the Douglas DC-8 would have been much the same. The *Comet* is a much smaller aircraft than either of those, and the pressure of economics would probably have meant that the *Comet* would not have been more saleable at this moment and in the near future if the disasters had not occurred, than it is now.

Mr. Woodley: We generally get some benefit out of unfortunate happenings, and as a result of the *Comet* disasters we increased our knowledge of fatigue. We have been stimulated to do more research on fatigue, and that in itself has been of benefit in the construction of subsequent aeroplanes.

The **Chairman:** Mr. Masefield's Paper outlined the situation very fairly but would presumably have been very different if we had sold a number of *Comets*. What would he say was the influence of the *Comet* disasters?

Mr. Masefield: I believe that the *Comet* disaster was a real tragedy for British aviation. Apart from the effect on the *Comet* itself, the effect was to put back everything on the British side and allow the

Americans to catch up to a considerable extent. For instance, the *Britannia* was delayed two years by the *Comet* disaster, because it had to go through all the water tank tests, but for which it would have been two years ahead of the position it in fact achieved. If it had been two years earlier, a great many more would have been sold.

Another thing is that B.O.A.C. would have come to a realisation more quickly than they did of the need for a large British jet transport aeroplane, on the experience of successful *Comet* operation as the first in the field of the jets. Our thinking in this country was towards pressing on with bigger and better development on the jet side, but that was halted, and although we now have the VC-10 coming along, it is later in date than it would otherwise have been. The disasters put back British transport aviation, turbo-props as well as jets, by at least two years and possibly four years and resulted in a shortage of export business. We are going to see the effect of that, not so much this year or next, but in three or four years from now, when the Americans are established in markets which we might have had. History teaches us that it is never possible to overtake a missed opportunity.

Mr. Turner: Another point worth mentioning is the effect on Government sentiment and public sentiment towards this industry. We are no longer so important as once we were. It is very difficult indeed at the moment to convince the Government that the aircraft industry is a worthwhile investment for hundreds of millions of pounds. If the *Comet* disasters had not taken place and we had had many more orders for *Comets*, I think that our prestige as an industry would have been very much higher than it is, and it would have been easier to get from the Government what we want, which is money.

The **Chairman:** Another question has been sent in on a similar topic :-

> *We have heard a great deal about American competition in civil air liners but very little about the likely impact of Russian developments. What markets are we likely to lose to Russian competition in civil aircraft, both production and operation?*

Lord Douglas: I have been to Russia and had conversations with designers and operators there. Undoubtedly Aeroflot, which is the only Russian air line, will expand its business. It is coming to London, and before long it will have ambitions to cross the Atlantic and fly to other parts of the world. That will mean that there will be more competition for everybody, including us, which I do not think is a bad thing. The more the Russians get outside Russia and join in world travel the better for everyone.

On the technical side, they have several good aeroplanes in service now, such as the T.U.-104, and coming along. The T.U.-104 is a good aeroplane, very fast, cruising at about 500 m.p.h. It also lands very fast and is rather noisy, but it is a successful and practical short- and medium-range transport aircraft. Behind that they showed me the Ilyushin-18, which is half-way between a *Viscount* and a *Vanguard,* a promising-looking turbo-prop. They are experimenting with very large transport aircraft carrying upwards of 200 passengers, with the idea of breaking into the cheap mass travel market, which I think is a move in the right direction.

We have to face the fact that the Russians are coming along quite well, though they started late. They will probably make an impact on the civil aviation of the world before very long. They have a very big network inside their own borders. We do not know at the moment quite how big that is.

Mr. Masefield: We must not underestimate the Russians, but we have to admit that they are naive commercially. They do not know much about the commercial side at present, but they will learn. Some of us have had experience of getting an American certificate of airworthiness for a British aeroplane, and we know how difficult that is, even when we meet all the requirements. I think that the Russians would have some difficulty in getting a certificate of airworthiness, if they went into the export business, under the British or under the American regulations. They do not design their aircraft to our requirements and standards, and their aircraft do not meet either the British or the American civil airworthiness requirements and they would probably find it extremely difficult to modify their aircraft to meet them, even if willing to do so.

In the short-term, therefore, I cannot see the Russians selling aircraft to the Western world. They might sell to India and similarly situated countries, but not to any Western air line, however attractive they made their prices, because of the difficulty of getting a passenger C. of A. They might have a profound influence, however, if they came in with their own airlines and undercut fares across the Atlantic or on other routes, and they may very well do this with their big turbo-prop aeroplane cruising at 500 m.p.h. They might bust the Atlantic route wide open, and that would be the one really good thing that the Russians might have done in the past 30 years. It would be interesting to see the result.

Mr. Woodley: I associate myself with the remarks of both the previous speakers, and would add that the well-known reluctance of Russia to provide information would, I think, make a reciprocal C. of A. almost impossible. They would probably be unwilling to give the information required to get approval. I do not think that for some years to come they can be a power in the export market, except among the near-Communist countries.

Mr. Turner: I think the prospect of Russia selling her aircraft in the world's markets under present conditions is virtually nil. All the operators in

the world, whether military or civil, want above everything else a first-class service and hate the thought of being cut off from the designing and manufacturing organisation. With international tension as it now exists I cannot see any operator buying a Russian aircraft, however attractive it may appear on paper, because he knows that he cannot depend on getting the service he needs to keep his aircraft flying.

The **Chairman** called for a question from the hall.

Professor J. Loxham, C.G.I.A., M.I.Mech.E., M.I.Prod.E., M.B.I.M. (*Head of Department of Aircraft Economics and Production, College of Aeronautics*) : This is the first of these Conferences that I have attended and I have found it very interesting and of great value. I would say, however, that it has been concerned with problems which are mainly of interest to designers rather than to production engineers. Some speakers have said, as did Mr. Vines, that there are aspects of our effort which could be devoted to more profitable ventures than flying at M : 5, and it may be more profitable for us as production engineers to concentrate on these.

On that theme, I would support the question put by Mr. Hollis and suggest that in the field of production engineering there is immense scope for carrying out very profitable research and obtaining immense gains at short-term periods. In this field of production engineering we have not touched the fringe of investigating the complex problems associated with engineering manufacture nor, indeed, has anyone else. We are not in competition with the Americans here, but we are to some extent with the Russians. I feel that if the Institution would organise a conference of this calibre, but concerned with fundamental scientific research into difficult production problems, we should do something of great value to this country and help our industries generally.

At a recent dinner at Cranfield, organised in connection with a conference on guided missiles, the guest of honour said that some 200 years ago James Watt invented the steam engine, but we were not at that time able to use to the full the benefits of this great invention because we were not able to manufacture the steam engine to the standards of accuracy required. He then said : " We are in precisely the same position today, because we cannot make the components that are required for guided missiles and similar equipment to the standards of accuracy and the degree of reliability that is required." In spite of this, I am certain that the achievement of high precision manufacture can be obtained at very little extra cost, and in some cases at no extra cost and I would like to ask the panel do they think that it would be a good thing for our next Conference to be concerned with research on a national scale into some of the problems of production engineering mentioned by Mr. Hollis?

The **Chairman:** The question is, should not we spend more of our money on methods of production engineering, and, if so, how would the panel propose to further this development?

Mr. Woodley: This Conference is held under the auspices of The Institution of Production Engineers, but it has been tied to a specific theme, aircraft, and that has been the emphasis in all the Papers. I agree that more money should be spent on production research, and it needs a stimulus in the form of the need to do something which is useful, such as dealing with the extremely difficult problems involved in aircraft manufacture, but I think that we must tie that research to other forms of research. The electronics field has been used to provide machine tool control, ultrasonics has been used for various processes and so on.

I am not sure whether the questioner means that there should be some form of national expenditure in a similar way to that for the development of aircraft. That is a possibility, but surely his own College of Aeronautics provides that facility. Perhaps he means that there should be more of it, and in that case I entirely agree. I think also that more money should be made available to enable him to do more, and that that should be complementary to the research undertaken by individual organisations, whose research is usually tied to their specific problems. As our specific problem is aeroplanes, we naturally have them in mind here.

Mr. Turner: As a non-engineer I should like to say that I agree with what the questioner may have in the back of his mind, namely, that too large a proportion of the money available for research and development has been spent on the design side and too little on the production side. There is no doubt, I think, that the production engineering side has tended to lag behind the design side. That is essentially a question of money. I do not know quite where the money will come from, but we should certainly improve the situation within the aircraft industry, quite apart from the impact on other industries, if only the designers and the production engineers got closer together. In many companies, in spite of the efforts made to improve the situation, they still look on themselves as realms apart.

Mr. Masefield: In the first place we have to have something to produce, and one thing we have talked about at this Conference is how to get something to produce. That is fundamental. I agree that a great deal of development and further research on prodution methods are needed. We are not so far advanced on skin milling, contour etching and that sort of thing as we should be, and we could do more with new materials, where we may lag a little behind America, and certainly on components, such as electrics, there is a great deal that can be done. Much of the unreliability of modern British civil aeroplanes is concerned with electrics, which are not good enough. From a

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production point of view we could well discuss with the Institution of Electrical Engineers how we and they, together, could improve the whole approach to the electrictery of a modern aeroplane.

There is a good deal that we could do in producing things more simply. We often go a very complex way about something which, with more thought and effort, could be done more simply. And we take too long over a lot of things in production. Even prototypes are taking two years to produce nowadays, whereas before the war we used experimental shop methods — which we seem to have forgotten about, but to which we might perhaps return today — to get prototypes out quickly. There is a great field here for discussion and development, but the first need is to have something to produce.

Mr. Woodley: We are underrating ourselves. We are not so far behind as may be thought; I do not believe that the Americans are further advanced than we are. We have the knowledge, but we do not have things to make in such quantities as the Americans. I know of no "know-how" or processes in America which do not exist in this country.

We have done well, but we must not stop; we have to go forward and spend more money. In that respect we might follow the example of America and have more Government-sponsored research into production than exists today. I think that Mr. Hollis will agree that many things could be done if the money were made available.

Professor Loxham : Referring to the question submitted by **Mr. W. S. Hollis,** I was talking recently to the training officer of a large organisation in this country, and one of the largest builders of electronic equipment for guided missiles, and he said: "We cannot persuade our graduate engineers with B.Sc. degrees to take up production engineering, because they do not think that production engineering is a process which can be analysed scientifically and this is the root of the trouble. In America, Germany, Switzerland and now more particularly in Russia this mistake is not made, and it should not be made here."

I recently demonstrated to one of my colleagues at Cranfield, who is an expert on plasticity, the plastic flow of metal in chip formation by means of a high speed film which I had taken and his comment was: "This is the most complicated problem in the plastic deformation of material that I have ever seen." I therefore submit, Mr. Chairman, that it would be in the best interests of this country for some of our most promising young engineers to take the new subject of Production Technology as their career.

Mr. Woodley: That is not my experience. I have had a number of graduates come to me and say "To hell with aircraft design! I want to get on to manufacture and production engineering." It is not my experience that they all want to go on the design side.

The **Chairman:** The suggestion is that production engineering has not been made into a science. Have the panel any suggestions on how this could be done? Does one have to learn on the shop floor the techniques of production? Have the panel any constructive suggestions for making production more scientific?

Mr. Woodley : I think that it is only in recent years that we have come to realise that the shop floor method is not necessarily the right one for learning production methods. We have brought in graduates. In the past, production engineers have taken second place to aircraft design engineers, and that has been reflected in their salary. We have to make the job attractive both financially and in the work done. We have to give them laboratories to work in. In that sense I agree that the matter is in our own hands, and it is not necessarily a question of money. It will cost more, but the benefits will be great.

The **Chairman:** Let us hope that the Institution will bear in mind the desirability of improving the scientific side of production.

The next question is:-

Does the panel agree with forced mergers of aircraft firms?

Mr. Turner: Forced mergers are complete nonsense. This is just political claptrap, put forward by politicians who may know little about the workings of industrial organisations. It is not sensible to try to insist on mergers in the absence of orders which would justify a still larger organisation. This question probably refers to a statement made by the Minister of Supply, who said in effect there was going to be less and less work for the industry to do and therefore there must be bigger and bigger units. To me, that seems extraordinarily illogical. There is one size required if an organisation is to cope with a job, at any rate from the economic point of view, and that is the right size. If the organisation is too big the cost will be too high; if the organisation is too small, either it will not be able to do the job or it will do the job too late.

I cannot see any point at all in forced mergers, although I recognise that if we get into the supersonic transport field no one company in the industry in this country could cope with that job, and we should see some form of collaboration taking place in the early stages which will probably lead to complete mergers later. But that is for a specific job. To do the merger first and look for the job later seems to me inappropriate.

The **Chairman:** Has that been suggested?

Mr. Turner : Yes. I think even the Minister of Supply suggested it once.

Mr. Masefield: I agree very largely with what Mr. Turner has said; there is a great deal of political claptrap about this. The policy arose initially in a naive attempt to avoid the unpleasant fact that some firms would have to go out of business because there was not enough work to go round. That was the political foundation of this; it does not make practical sense to merge in order to do less work, and all that it means is that you keep one or two more people on the board of directors and rather fewer people in the shops.

It is obvious that if we are going to get jobs which are beyond our resources — and supersonic transport may well be one — we have to find means of tackling them with more resources. The only other point about mergers is to make available more capital to undertake particular tasks. That also stems, I think, from an unfortunate series of conceptions, or misconceptions. The reason why individual companies have not enough capital to do particular jobs is that the jobs they hope to get are not attractive enough financially for them to go on the market to raise capital, and so they can only go to somebody who has some capital and get that.

My own feeling is that "working arrangements" to do work, so as to obtain more technical know-how or shop capacity for a job, are a good idea, a way of obtaining a good combination of forces. Mergers may follow if the "working arrangement" leads to big business and a bigger set-up is needed. But one thing that we know from a production engineering and designing point of view, and also from a general management point of view, is that a wide amount of spread work in geographically separated places all over the country is inefficient and leads to a great deal of extra supervision. Mergers might tend to give us a lot of scattered, decentralised units all over the country, which could, in the absence of enough work to keep them all going, lead to inefficiency. This is not an answer to all the problems, but merely an attempt to avoid unpleasant facts. The answer is to get more work and bring to that work the strength to do it properly.

Mr. Woodley: If the politicians sought the advice of the Marriage Guidance Council they would learn that shot-gun marriages do not pay off. These things will have to take their own course. Mergers can follow a project, but they must be natural mergers, not forced.

The **Chairman:** Lord Douglas, you see this from the outside, and will probably be more objective than the other three.

Lord Douglas: I have no strong views on it. All I know is that when we were trying to order the DH.121 from de Havilland, we were held up for several months because the question of mergers arose before they could deal with the order.

Mr. Turner: I think that most of us in the industry would be horrified at the prospect of the aircraft industry being nationalised. If we have only two or three airframe organisations and one or two engine organisations it would be very much easier for the Government to nationalise them in one form or another than if we are organised as at present. But, having said that, I think it is inevitable that over the next 10 years the number of independent firms in the industry will contract severely. This must be arranged, however, on a voluntary and not on a forced basis.

The **Chairman:** Are there any supplementary questions on this ?

In certain circumstances more massive support may be necessary from the Government. Do the panel believe that any rearrangement of the structure of firms will then be necessary, such as accepting Government nominees on the board?

The **Chairman:** If firms have to combine, what is the sort of framework envisaged for the combination ? Would you like to see Government nominees on the board ?

The Conference has discussed the advisability of forming a committee to decide on the path which the aircraft industry should follow. Would the panel support this suggestion and, if so, would they be prepared to indicate the constitution of such a body ?

The **Chairman** asked the member putting the second question whether he had in mind something on the lines of the Cadman Committee or a Big Five to control the destinies of the whole aircraft industry. The questioner replied that he envisaged a committee consisting of people drawn from the various parts of the industry and from the users of aircraft.

Mr. Masefield: The first question concerned the structure of the industry, if we have to have a great deal more Government support, which we shall need if we go into the supersonic transport business. My feeling is that it is not where the people come from that counts in conducting the destinies of any business but the men themselves, and therefore a nominee simply representing a particular interest is of no help. What does help is to get really informed, aggressive and knowledgeable minds allied to the tasks which one is trying to accomplish. If we get better men, we should welcome it; if we get merely nominees who know nothing about the business, that is of no use or interest to anybody. Whether an organisation is nationalised or privately owned is of mainly academic interest; the major issue is who is running it. The people who do the job and decide the policy are the people who count, and, whoever owns the business, the people who are put into it are those who really matter. The question should be dealt with on that basis. Government nominees would not necessarily be the right sort of people to assist in a difficult task. Only the men count, whether in directing policy or in production or wherever it may be.

I am not sure that I have understood the second question. Yesterday I said that I believed the time was ripe for a fundamental review of our industry over the whole spectrum of what we ought to do and the limited objectives which we ought to set ourselves. We should not try blindly to do everything at once, but should recognise the directions in which we should focus our energies and then go flat out, with all the money that is needed in those conditions. I think that that could be done only by having a wide committee with someone of great ability and commanding great respect and an analytical mind at the top, who is not in the industry or the Government but who is well aware of the problems. I hesitate to mention names, but there are

people of high stature who could do the job. I look for a Brabazon/Cadman type of committee with the widest terms of reference to consider the whole of British aviation — not just the industry but aviation as a whole, because the Government are tangled up on the operating side as well, with the problem of the independent operators and so on.

Mr. Turner: Dealing with the first question, on the effect on the structure of companies, if we did a supersonic transport scheme in this country I do not see how it would be possible for three or four companies to do the job on the basis of equal partnership; somebody would have to be the leader and the final design authority, and that must vest in one company, not in three or four. Even though three or four companies might be associated on the job, one of them might have to be the leader. It might well be that the leader would be the biggest, and that as a result the policy of mergers in the industry would be brought nearer to fruition. That is the way that things might go. Some firm would have to have the primary responsibility.

Mr. W. F. S. Woodford (*Secretary, I.Prod.E.*): May I ask a supplementary question ? No one in his senses would quarrel with the idea that it is men who matter. I have noticed a certain uneasiness in the minds of top people in the industry about their personal future. Does the panel think that there is a danger in the Government's present policy of contracting the industry that the industry will lose some of its best men ?

Mr. Masefield: Yes. (*Laughter*)

The **Chairman:** Where are you going ? (*Laughter*)

Mr. Woodley: If we look at the matter from a national point of view, those people who are now in the aircraft industry might do as good or a better job in another firm. It is not a question of losing them but of transferring them somewhere else. With the reduction in the number of employees working on aircraft we must have diversification, or strengthen other industries with those who become redundant. I do not think that the problem is important. Their talents can be equally well employed elsewhere, and they will probably give a shot in the arm to industries which are at present lagging sadly behind.

The **Chairman:** We will pass to the next question :-

> *Lord Douglas has said that he has been unable to make a profit on the shorter hauls than 200 miles. Has the panel any views regarding the provision of aircraft to overcome this ?*

We must take this in a broad sense. Can we have an aircraft system which makes a profit for distances of less than 200 miles ?

Lord Douglas: I believe that if we set out to design an aircraft specifically for the job it would be possible to bring down the costs of operating these short hauls and get nearer to making a profit. But the fact remains that, whatever type of aircraft is used, it is not the cost of running the aircraft which matters so much as the cost of dealing with the passengers, issuing their tickets, getting them on board and getting them off at the other end. The bill for landing fees goes up and the costs go up generally on short hauls, and the shorter the route the higher the costs must be compared with the long haul routes. That is the difficulty. I think that the design of special aircraft would help, but I do not think that it would solve the problem.

Mr. Turner: I think that Lord Douglas is right. This is not, perhaps, an industry point, but rather one on which we should speak as individuals. I believe that the aircraft passenger is costing far too much. He is treated as a complete nitwit, unable to read or walk. Passengers do not, to the best of my belief, go through this sort of procedure in America. It is interesting to compare all the red tape attached to an internal air service in this country with what happens on the railways or long-distance buses, where nobody worries about you and you get on the vehicle yourself. There is too much fuss made of the passengers by air and it must lead to unnecessary overheads.

Lord Douglas: These short hauls do not pay in America either and have to be heavily subsidised on that account.

Mr. Turner: But I take it you agree that we could reduce the amount of wet nursing of the passenger ?

Lord Douglas: There it is a question of the frequency of the service. You stand and wait for a No. 11 bus because they come along at frequent intervals. If air services could be run at such a frequency that people could simply turn up and get on board it would be a cheap way of doing it, but unfortunately the number of our passengers at the moment is not sufficient to permit a frequency of that sort, except on a very small number of routes. The service between New York and Chicago has reached that stage, and the passengers simply walk on board, thereby saving expense to the operator. The service from London to Paris is getting that way, but it could not happen on any short haul route inside Britain. There is no route which could support a frequency of one aircraft every hour, with enough passengers to make it pay its way.

Mr. Turner: If the air lines in this country could operate really regular services under all weather conditions it would make a big difference. Professor Richards, our present Chairman, in some remarks yesterday from the body of the hall, commented on the improvements which might come about as a result of blind landing and take-off developments. That would bring down costs and make it possible to have very regular internal air services, so that passengers could be trained to act

for themselves and to use the plane as they would a bus. I very much hope that the operators in this country will start thinking on those lines, because the aircraft industry is going to become busy again only if there is a real growth in air transport, and this is one way of ensuring that that growth takes place.

Mr. Woodley: Lord Douglas referred twice to landing fees. Surely the fees are geared to the cost of running the airport, and with greater frequency of service they could be reduced ?

Lord Douglas: We have tried already to get a reduction for quantity !

Mr. Woodley: Supporting what Mr. Turner has said, I have had to get to London Airport three-quarters of an hour before take-off time, and even then I almost missed the plane, because I had to be processed. That tends to put people off. I agree with Mr. Turner, having just come back from America, that passengers are not half so well looked after on the short hops in America as they are on B.E.A. flights and have to find their own way on and off the aeroplane, but it seems quicker and more natural. An extension of that system here should promote more internal travel and give us more work.

Mr. Masefield: I have a great deal of sympathy with what Lord Douglas has said, having myself experience of the same problems. On these short distances the aeroplane is on the ground for too much of the time, and with frequent landings it has to taxi in and out, take off and land, for a bigger proportion of the day, and therefore it is more expensive. Every time an aeroplane lands it is going to cost £50. It may be possible to trim £10 off that, but not much more. We have to provide some means of getting from city centre to city centre so as not to pile on these heavy terminal costs and to avoid the great delay at the airport, which accounts for half the time in getting from London to Paris. We must provide city to city transport from the centre of the city, and we have to look to V.T.O.L or the Rotodyne or some other type of helicopter, or to vertical take-off aircraft of some other sort, if we are going to make any sense of the short-haul services. We hope that such aircraft can be produced and can be run at economic fares. The helicopter at the moment is an expensive method of travel, and only by making it bigger can we get the costs down. With that and blind landing we may go a long way towards solving the problem. But if not, the best solution of the London-Paris problem will be the Channel Tunnel !

The **Chairman:** I think that that is an unfriendly ending. I was wondering what line Mr. Masefield was going to take up when he left the aircraft industry !

I have another question here :-

> *In view of the low fares charged by the charter companies, would it be a retrograde step to abolish the scheduled air lines and extend the charter system ?*

Lord Douglas: I think that that is outside the scope of this Conference; it has nothing to do with the problems of aircraft production. I do not understand the point of the question. Does it refer to getting rid altogether of scheduled services working to a time-table, or to breaking up the Corporations and handing over all their business to the independent air lines ?

The **Chairman:** I think the questioner has in mind that there would be more aircraft sold if the fares were brought down to those of the charter services.

Lord Douglas: If he refers to the cheap fares which are being put forward by some of the independent operators, I think the opposite would happen, because what they are proposing to do is to run old-fashioned aircraft at very infrequent intervals at very low fares, and it would not require more aircraft to do that. It is simply a way of using up old aircraft, and it would not give the public a regular and frequent service. If this sort of thing became the rule, it would have the opposite effect and would not lead to the production of more aircraft.

> *Is Lord Douglas prepared to comment on the "great divide?" He made it clear that there were two courses open: high speeds and high fares, or more workaday aircraft at low fares.*

Lord Douglas: I should like to see more development in both, but we should stay in the Low Fare League. I am a great exponent of low fares and have been trying hard to get the fares down. That is our object in B.E.A., because we believe in mass travel. I agree with what Mr. Masefield said yesterday about making aeroplanes which will carry people not necessarily at very high speed but at very low cost, because that is what the great mass of the public require. The "great divide" is a very illuminating way of putting it. We ought to stay in both fields, but we must stay in the mass travel field, whatever we do about supersonic aircraft.

Mr. Masefield: I can hardly disagree with that, but I think that substantial progress could be made in both directions and I do not believe that we need a revolution to achieve it. If we turn some of our technical and production resources on to producing a new cheap aeroplane, we ought to be able to make one which is cheaper than all the obsolete machines on the charter side. A new turbo-prop or fan jet engine, having low consumption at speeds between 350 m.p.h. - 500 m.p.h., would in my belief, if we made the right type of aeroplane, enable us to cut fares — which Lord Douglas has advocated doing — to about half. I believe that that is in prospect and that we might be able to go lower still.

We in the aircraft industry have to be asked to produce such an aeroplane, and so far no air line has come to us and asked us to make a cheap aeroplane. My feeling is that very fast new aeroplanes are going to be more expensive, especially if for other reasons they have to be very big — and they do not

get their seat-mile costs down unless they are very big — which means that in the off season, when they run two-thirds empty, they are going to cost a lot of money, so that whatever their seat-mile cost is, their aircraft-mile cost will be very high.

We ought to recognise this division and get the differential fare which Lord Douglas has been advocating but B.O.A.C. have strenuously opposed.

On the previous question, we seem to be getting to an interesting stage in high-speed development when we can go anywhere in two hours. It will take us at least an hour to get to Paris, and probably two hours, because of terminal delays. If we get hypersonic aeroplanes we can get to Australia in two hours. The interesting position will be reached, therefore, that we shall be able to go anywhere in the world in two hours, though it will be more expensive to go a long journey than a short one, but less frustrating, because a smaller proportion of the time will be spent messing about and a larger proportion in actual travelling.

Mr. Turner: I should like to bring the panel back to earth and return to the original question about the independent operators. The point was brought out clearly by Lord Douglas in his Paper that the British aircraft industry can effectively develop a new aircraft only with the all-out assistance of a major operator at home. We in Blackburns are not making civil aircraft, but I should hate to think of developing a large transport aircraft with the independent operators as they are now. I think that this is a very important point to bear in mind. The State Corporations help the industry greatly, and I should like to see them do more. The industry would undoubtedly suffer a great deal by the disappearance of the Corporations, leaving the field to the independent operators. As individuals, I think most of us would feel happier to fly in aircraft belonging to the State Corporations than in those of some independent operators. I believe that we should have both, and personally as a passenger (though I hardly ever pay my own fare) feel that the independent operators will do a very good service if they stick a needle into Lord Douglas from time to time !

The **Chairman:** That is a very good final comment on that question. Another question has just come in :-

> *What is the panel's view on the question of interdependence ? Should we strive towards industrial integration with N.A.T.O. countries, the Commonwealth and the U.S.A. and reach agreement on the division of projects, both military and civil, thus ensuring a guaranteed share of the aircraft and missile market of the world ?*

Mr. Turner: I think that there is something to be said for that point of view if one is pessimistic or ultra-realistic. We find in the industry very great difficulty in selling our products to the U.S.A. We must recognise that the Commonwealth as such is not an enormous market for our products. The Commonwealth in the large aircraft field consists of very little more than Australia and Canada, and both those countries are very much in the American sphere of influence. We have Europe as a considerable potential market, but we are losing out fast in Europe because of the association of France, Italy, Germany and Benelux in the Common Market. If we are not careful we shall find that our overseas markets are shrinking rapidly because of lack of political awareness of what is going on, especially in Europe. Perhaps the question goes too far in talking about a share in the world market; personally I should feel happy if politically we got into Europe.

Mr. Masefield: This is a very difficult and important question. One of the difficulties with N.A.T.O. is that it is not possible to get decisions from it on anything concerned with the industrial front. The delays experienced in this country are multiplied by 10 when dealing with N.A.T.O., because so many countries have to be consulted; and so, though we should continue to go after them, we should not have too much hope of getting anywhere with N.A.T.O. orders. Let us try for all we are worth but not be optimistic.

The Common Market can be a disaster for us industrially unless we do something about it; somehow we have to get a foot in the door or we shall be frozen out, and that could be very serious for any export aspirations which we may have so far as the continent of Europe is concerned.

Collaboration with America does make some sense, and we should seriously consider it in relation to supersonic transport, if the Americans are willing to collaborate. It is a way of giving the Western alliance a practical industrial form in peace-time and, if carefully worked out, something useful might come out of that. This is a problem of politics and industry combined and has to be examined very carefully indeed.

Lord Douglas: This is a very good question, and one which faces us in B.E.A. at the present time. More than one engine manufacturer has written to me urging me to get into the Common Market and join in a common unit in order that the continental countries can buy British aircraft and engines. That is reasonable from the makers' point of view but not attractive for B.E.A., because, looking at the matter objectively, we feel that we have more to lose than to gain by getting into this Common Market consortium. We carry more of the European traffic than any other air line, and the majority of the traffic from this country to Europe, because this is the biggest generating centre for air travel of any country in Europe. It looks as though if we went into a consortium we should lose some of our present share to satisfy the other members. I do not say that that is wrong, but we have to watch the situation very carefully. If we come to the conclusion to go into a consortium with the Common Market or with some other group of air lines we shall do so, but the situation is so fluid that it is difficult to find out what is happening, and we shall want to see the position much more clearly before we take the plunge.

Mr. Woodley: I look on this with mixed feelings. It is very similar to a forced merger. We want to get these various countries to talk with one voice. I remember reading about the discussion on what is a sandwich. Is not that the sort of thing that will happen generally ? I can remember going to meetings to decide on a unified thread, and we got it, but basically it was an American one. We have to go into the European market, but we have to be sure that we get our share, and the sort of sharing out which may take place may not suit us. Shall we get a fair share ? If the finance is available we have to produce the best and the cheapest and sell them on that basis.

The **Chairman:** The conclusion seems to be that we shall go in if we find that it pays us to do so. I should now like a question from the floor.

What are the panel's views on the suggestion made yesterday that there is a case for the development of a heavy goods air transport system ? Mr. Masefield said that the industry had never been asked for such an aeroplane, but if the industry is looking for work it seems reasonable that it should take the matter up.

The **Chairman:** Another question has been sent in which can be taken with that one :-

Many types of aircraft are now required which are not of direct use to B.E.A. and B.O.A.C. Will the members of the panel propose a system for financing such aircraft ?

Mr. Masefield: I think that the answer to the first question is "Yes", there is a demand for the heavy freight aircraft, which may also be of some use for low-cost passenger services. The way in which this could be done would be to link Transport Command's requirements with the needs of low-cost air freighting, and that is where Transport Command could be particularly helpful. We know that recently an order has gone to Belfast for a large freight aeroplane. Frankly, I think that this was a political rather than a technical decision, in that Northern Ireland is terribly short of work, and from that point of view it made sense, but from the point of view of producing an aeroplane which will sell widely in the world's markets I am not sure that the decision was correct, because the sort of aeroplane needed for commercial freight may differ from this military adaptation.

If, for instance, we get a realistic requirement for transporting guided missiles half-way round the world, that will pay for the development of such an aeroplane. We could then expect a reasonable depth of market, priming the pump with a military order as the Americans do. If there is not an order from Transport Command or from one of the Corporations, the Government should do what the Cadman Committee recommended 20 years ago. They ought to do what they did with the Brabazon Recommendations which produced the *Comet* and the *Viscount*. They should order prototypes and recoup on the commercial success of the aeroplane.

There are precedents for that, such as the Fairey FC-1 which Lord Douglas illustrated, and the Brabazon types and others. Both Conservative and Labour Governments have endorsed this policy. In that way we could get these bread-and-butter types, whether big freighters or Viscount/Convair replacements or DC-3 replacements. And if they are a success the Government would get its money back. There was a substantial profit on the *Viscount*, and they did not do too badly on the *Britannia*. What we need now is a national policy for British aeronautics.

Lord Douglas: I agree with Peter Masefield's views. I think that the Government should sponsor the design and development of new types to fill gaps in the spectrum, as he has said, and I believe, from my knowledge of what is going on now in Government circles, that there is a very good chance that this may happen. We have to go on pressing for it.

Freight is difficult, and to some extent there is a vicious circle of a chicken-and-egg situation. The trouble about freight, as Mr. Masefield said yesterday, is that air transport is too expensive to attract the large quantities needed to justify the construction of large aircraft, and most of the air lines of the world feel that passengers are a more attractive proposition than freight, because we get more for carrying human bodies than inanimate lumps of freight, and that will always be so. The only way to get more freight, and freight in large bulk, is to get the costs of air freighting down, and that is what we must try to do. A good many air lines, and indeed the purely freight lines, try to keep the freight rates up rather than let them go down. There is a limit to their possible reduction, or you may find that the more you fly the more you lose, because the rate is too low for a profit. There is a case, however, for the large specialised freighter which Mr. Masefield talked about, which will attract bulk freight by low cost.

Has any aircraft manufacturer in this country drawn up a specification for a reasonable-sized freighter and gone to any customer, Government or air line, and said "We think you need this; it will earn you money?"

Lord Douglas: Yes. One firm has put that to us.

The **Chairman:** I have a good question here which is aimed at Mr. Turner :-

In view of the marginal economic state of the aircraft industry, is a good accountant more important than a good designer or production engineer ?

I think the answer is that a top man can deal with anything.

Mr. Turner: I think that the short answer is "No". The design and manufacture of aircraft is essentially a team business, but history has shown in the last 20 years that aircraft have really been sold, by and large, on their performance, and during that time the first-class designer has perhaps been

the most important member of the team so far as getting work is concerned. No accountant can make money in the aircraft industry unless something is made, and the accountant is not good at designing or producing aircraft. When the aircraft industry is diversifying and going into other activities where profit margins are less and less, I think that the accountant may become more important than he has been in the past. It is a question of personalities, and who is the right person to be captain of the team : do you want a batsman, a bowler or an all-rounder ?

Mr. Masefield: I think that that is a very wise answer. The question is rather like "Have you stopped beating your wife?"

The **Chairman:** We might ask that one as well! I have three questions here which I think can be summed up in this form :-

> *While it has been said that there is an interchange of technical information between the aircraft industry and those which are not quite so skilled, the fact remains that the skill in the aircraft industry has not penetrated to the other transport industries. The train service has not really been altered very much and the shipping system has not altered very much; therefore, are we really over-stating the value of the aircraft industry to other industries ?*

Mr. Woodley: The railways at the moment are introducing automatic train control. Because of the nature of our business and the outlook which it requires nothing seems impossible, and we can tackle a difficult problem quite differently from the way in which others would deal with it. I do not think that it is possible to overestimate the value of this industry to others. Diversification rather than a mere transfer of knowledge seems to me to be the answer, but if people leave this industry and go to others the knowledge will be transmitted in that way. We have a great deal to offer to other forms of transport.

Mr. Turner: Up to now the aircraft industry has been very largely an armament industry. We have had during the life of the aircraft industry two long World Wars, which have given the industry a tremendous stimulus, and I should have thought that the questioner is right, that as a result of this we have perhaps come to look on ourselves as being rather more important than other industries. I think that that is true in the times in which we have been living but, if the aircraft industry is not going to be so important from the armament angle in the years to come, we shall probably have to start taking off our hats to other industries now and again.

> *In the civil field there appear to be two spheres of activity, on the one hand speed and prestige, and on the other economy and profit. In each of these spheres it seems that quite heavy Government support of one sort or another will be required. If the Government were to say "We will support you in one or the other, but not in both" which would the members of the panel choose ?*

Lord Douglas: From the rather narrow point of view of B.E.A. I would go for the mass travel side, because supersonics will not help us. You will not get to Paris any more quickly at 2,000 m.p.h. than at 500 m.p.h., as Mr. Masefield has pointed out; it will take you about two hours in any case. I think that we have to go for the mass travel market.

Mr. Masefield: I support that. If we have to make a choice we should go for the mass travel market, because that is where production will be most required, and we have a responsibility to ensure employment for our personnel. We shall be able to provide employment in a big way, not in supersonics (though we should like to go for that if we can afford it) but in providing a lot of aeroplanes for a lot of air transport.

We have to recognise, however, that this would mean Government support in a different way from in the supersonic field. It would mean Government support internationally to a very big extent, because if we came out with a very cheap aeroplane which would halve the cost of trans-Atlantic travel, and we wanted to use it to charge say £70 return, to New York, the immediate reaction would be that which faces B.O.A.C. on the Pacific, an attempt by the Americans to prevent us from doing it, so as not to undercut Pan-American. We should have a real tussle with the United States Government. If we said "You cannot come here unless we go to you," they would attempt to cut us out and to fly only to Paris and Brussels and Amsterdam. But if we meant business I think that we should in the end be selling aeroplanes to Pan-American, and I do not think that we shall ever sell supersonics to Pan-American, because they will have their own. It would mean an international political fight as well as a technical exercise.

The **Chairman:** I have another question here :-

> *Does the panel agree with the conclusions of the Supersonic Air Transport Committee ?*

We had been hoping to have Sir Arnold Hall here to take part in the panel, and that the sparks would fly, but at the last minute he was unable to come, so that to that extent we do not have a full team to deal with this. Do the panel want to say any more about this ?

Mr. Woodley: No.

The **Chairman:** I think that the feeling on this is fairly well-known. There is need for a body of people of high authority to study this question from the points of view of economics and prestige rather than from the technical viewpoint. There was, I believe, unanimity on that.

We must now come to the last question, and I have kept this one for the end partly because it is of interest, and partly because up to now the members of the panel have been referring to their organisations, and this is a personal question :-

> *Would the members of the panel be pleased to allow their sons to enter the aircraft industry?*

This is where the members of the panel have to speak the truth. (*Laughter*) Up to now, I mean, their views

may have been coloured by those of their organisations. If they have no son or sons, they must invent them for this purpose.

Lord Douglas: I have no sons, but I have a daughter, and my ambition is that she should be the first woman captain in B.E.A.

Mr. Turner: It is unlikely that I would have a son who was capable of being an engineer. If I had a son who insisted on being an engineer, my view would be that he could not possibly get a better mechanical engineering training than he would get in the aircraft industry. If he wanted to be a mechanical engineer in the broadest sense I would certainly encourage him to go into the aircraft industry in the early stages, and it would depend very much on his ability and on the state of the industry generally whether or not he remained in it.

On the whole, anyone who is wise should get into an industry which is expanding. If some of the things about which we have been talking for the last two days come to pass, and we start doing something for the mass transport of people and producing large numbers of aeroplanes, so that we have a developing industry, there should be a very good future in it. But if the industry is going to go downhill then, having obtained his initial training in it, I would suggest that he should look elsewhere.

The **Chairman:** In other words, you are going to put up the overheads of the aircraft industry !

Mr. Woodley: To me this question is hypothetical. I should let my son do the job he wanted to do. If he wanted to come into this industry, I should most certainly agree. It is on a pretty broad basis, and almost everything he learned would have an application somewhere else. I agree that it no longer has the glamour which it used to have, but I should certainly let my hypothetical son come into this industry.

Mr. Masefield: I have a son and he is trying to be an engineer. He is crazy, and it does help ! I think that he will go into the aircraft industry, though I will not say which firm. He will not do so for four or five years, so that he will be able to see which way the wind is blowing.

As a general comment, this business was founded by enthusiasts and all the pioneers were enthusiasts or they would not have been pioneers. We want more dedicated enthusiasts, and when we get them we shall make a real go of it. The difficulties which we are now going through will ensure that the people who come in *are* dedicated enthusiasts, because the others will not come in. I feel optimistic, therefore, about what will happen. I believe that we shall have a smaller, streamlined, enthusiastic industry dedicated to aviation, and I hope that my son and others who are mad keen on aviation — production, design, general engineering or administration — will come in and make a real go of it. If we can get that enthusiasm we shall see an expansion of this business. I think that "general aviation" — the smaller types — can have a tremendous application in this country, and even more in the Commonwealth, for executive travel, crop dusting and so on. There will be tremendous opportunities for the small, simple aeroplane, built in hundreds, and I hope that with real enthusiasm we shall produce that. We need enthusiasm on the financial side. Sometimes this is looked on as just another business. I do not look on it in that way. I think that it is something in which it is worth showing a dedicated interest, and, if we get that, the sky is the limit.

The **Chairman:** That is a very good note on which to end this session, the note of enthusiasm. As a teacher here, I can see very clearly that in the past the aircraft industry has been willing to take almost anybody, with one arm, one leg and very little head. That is not the way to make the whole show an efficient one.

I do not feel that I should try to sum up the opinions of the panel, but I think that we have gained a great deal by hearing the views of such eminent people on such a variety of subjects. The emphasis on the need for a national policy and for a body of people to survey the whole issue, including small aircraft and larger, cheap aircraft is very important. The only thing that makes me a little sad is that whenever we have a production conference we always seem to get on to general issues such as where the money is coming from and issues of organisation rather than of production as such. I think the truth is that there is no production here, but development and small batch work; but as an outsider I was sorry to find that there was not much discussion of production engineering and that so few questions on the subject were put.

I thank Lord Douglas, Mr. Masefield, Mr. Woodley and Mr. Turner very much for taking part in this panel, and on your behalf say how grateful we all are to them. (*Applause*)

CLOSING OF THE CONFERENCE

Mr. J. B. Turner, M.I.Prod.E. (*Chairman of the Southampton Section*) in closing the Conference, said the meat of the Conference had been placed before those attending it and had been consumed, though not yet, he thought, fully digested. Suggestions had been made from which could be developed another Conference next year. Pleasant things had been said about the theme of the present Conference. That theme had been chosen as the result of a discussion at a preliminary meeting attended by many members of the aircraft industry, and he thanked those companies that had sent representatives to that meeting and made the choice of the theme possible.

It was his pleasant duty to thank Southampton University for the facilities placed at the disposal of the Conference, and in particular to thank the refectory staff, and also to thank the authors for the excellence of their Papers and the members of the Southampton Section Committee, who had ably supported him in organising the Conference, and especially Mr. D. L. Wiggins, who had played a large part. Finally, he thanked Mr. Woodford and the other members of the headquarters staff of the Institution, who had made everything tick.

The Conference then ended.

CORRESPONDENCE

"SOME IMPRESSIONS OF GERMANY AND SWITZERLAND"

From: **Herr H. H. Wolff**, Dipl.-Ing., M.B.A.
Laboratorium für Werkzeugmaschinen und Betriebslehre der Technischen Hochschule, Aachen.

BEING a reader of the Journal for several years now, I do not hesitate to say that you are doing in general a very fine job on the magazine and that I have found many useful and valuable articles in your issues. But my reason for writing now is not to compliment you on the Journal, but to raise some objections to an article in the January, 1959, issue — "Some Impressions of Germany and Switzerland" by Mr. H. Scholes.

If it is intended to present to Journal readers the facts — even though described as "some impressions" — about engineering practice and education in Germany, the investigation should be on a much broader basis. The situation in one city should not be regarded as that obtaining throughout Germany, as the majority of readers may accept the data and facts given in Mr. Scholes' article as representative of German industry and German engineers. The author visited only five companies, in Kassel, which is situated right on the East German border, was completely destroyed during the last War, and is everything but a typical industrial centre.

The only well-known company in production engineering of the five visited is Henschel, which unfortunately went bankrupt last year. The industry in the Stuttgart area, the Rhine-Ruhr district, or Hannover, Salzgitter-Wolfsburg has not even been mentioned. Therefore, the "impressions" are of little value to assess the German post-War situation. But even taking this into consideration I still don't understand the author's remarks, which show little judgment in some respects.

For example, on page 19 he says: "In other zones the influence of the occupying powers is not so obvious, perhaps unfortunately." I agree that the American soldiers were, in many respects, a very healthy influence. But if a young generation comes to know each other so well, the advantage of exchange definitely works both ways, though personally I am doubtful, if Mr. Scholes is all in favour of jeans, Coca-Cola, etc. I don't quite see his point here.

I would like to know what Mr. Scholes understands by "reasonable free traffic between zones". It is almost impossible for us to get in, and from the other side of the Curtain to get out, of East Germany. I am sure he forgot that there is only one Germany, and that it is more difficult for West Germans to go to Leipzig today than to Moscow or New York.

Marshall Aid is not ignored at all, as it is a very important support. But its main value was not the amount itself ($3.6 billion) — the United Kingdom received about 10 times this amount — but its timely arrival and its considered investment industry.

Mr. Scholes says: "Some of the pre-War aristocracy seem to be back in power: this to me seems to be a good example of the German acceptance of the divine right of authority in many spheres." In Germany as well as in England, the accomplishments of an industrial leader are the primary, if not the only, means of measuring his value and establishing his authority. Moreover, it was impossible in Germany after the War to replace a whole generation of our industrial leadership within a few years, and if these men were good before the War, why shouldn't they be good now? The right of authority has to be earned first, in Germany no less than in England, although we have no Earls or Lords who won most of their rights by inheritance.

Mr. Scholes also says: "Although as individuals I found them (the Germans) charming . . . I could not forget the years between 1933 and 1945." Why couldn't he? Many of my English friends did their best in 1959 to forget what happened, since they knew that not every German was identical with the Nazis. Maybe the sight of the bombed cities made it difficult for him to forget the years we were not able to work together.

variation in standard

There are many little details in Mr. Scholes' article I would like to mention; but I will refer to only a few more. On page 21 it is stated that the standard of content varies from one University to another. It does, due to the qualification of Professors and the equipment which Government or industry can supply. But you can change without difficulty from one of the eight Technical Universities in Germany to another. Moreover, the standard is set by the research work done at the Institutes (unlike England, the greater part of research work is carried out at centralised University Institutes) which, for example, make Munich famous for thermodynamics, Aachen for mining and machine tools, and so on,

though most technical subjects are taught at all these schools. So far, Hessen is the only district where the student does not have to pay for tuition. At all the other Universities, at least part of the tuition has to be paid for by the student.

The "Business Engineer", a new combination of engineering and economics, has not so far proved at all to be what was expected. This is just a minor experiment at Darmstadt and Berlin, which is not to be followed by the other Universities.

Comparing the "Graduate Engineer" with the "R.E.F.A. Engineer" sounds like a good deal of misunderstanding. A glance at one of the German papers proves that we distinguish precisely between Diplom-Ingenieur, Fachschule-Ingenieur, R.E.F.A.-Ingenieur, etc. The title "engineer" itself, as in England, conveys nothing of specific qualifications.

Another statement by Mr. Scholes, on page 22, says that the "thoroughness of application rather than original thought characterises German organisation of factories, and the efficiency of management means that the workmen work hard and conscientiously for relatively low wages". If the first statement had been made about Americans, I would agree. But I would refer to only two of many examples of original thought — those which led to the development of the V1 and the V2 — not to mention nuclear physics and atomic energy by American technicians, as well as English and Russian engineers, which are everything but pure application without originality.

When I look at the second statement, that the efficiency of German management means hard work for the workmen, I am not sure if Mr. Scholes is a production engineer, able to compare the English and German situation, or if he is a German Labour Union official fighting for more pay for less work.

I hope you will understand me bringing this to your attention, since the Journal has a wide circulation on the Continent. But I would like to assure you that every German who is fairly familiar with the situation here, will be unable to understand how an article like this one can be written today, after there has been so much exchange between our countries — fortunately, in general, with much better results. I personally know a number of English engineers who would never agree with the statements made by Mr. Scholes. Though I lived in England myself for more than six months, I would not dare to characterise the English situation in general, at least not without contacting an Englishman beforehand on the impressions received.

Mr. Scholes replies :

INEVITABLY there will always be disagreement on matters of opinion, but if Herr Wolff will read my article again, he will find several references to "my limited experiences in one town"; "My particular examples are taken from Hesse" and to the geographical location of Kassel. (It may interest readers and Herr Wolff to know that Kassel, although almost destroyed during the War, is now virtually rebuilt and very impressively, too.) I can take no blame for the fact that Henschel and Sohn went bankrupt. As regards production engineering reputations, I suggest that A.E.G. and Spinnfaser have also devoted a good deal of thought to engineering their production.

Apparently Herr Wolff and I agree on the need for inter-communication between the occupying powers and the German people. My point was precisely that, in the British occupied zone, this mutual influence was not obvious in the towns I visited.

As for traffic between zones, the family I stayed with had just returned from a holiday in the East Zone, and went there, on the average, once a month in their car. Within the one family's acquaintance I met several people in Kassel for a holiday from the East Zone. However, I found it impossible to travel there myself.

Concerning "divine right of authority", I actually wrote "some of the pre-War aristocracy *of industry* seem to be back in power", two examples being Herr Krupp and Herr Henschel, who again were running family businesses after various post-War adventures.

I fail to see the point regarding "Graduate Engineer" and "R.E.F.A. Engineer". Surely, I made quite clear the emphasis placed in Germany on the qualifications and titles of engineers as distinct from the United Kingdom. However, the German Parliament certainly did pass a law restricting the title of "engineer" to those with prescribed qualifications.

Herr Wolff has misinterpreted my comment that "thoroughness of application rather than original thought characterises German organisation of factories" which refers (not surprisingly) to the organisation of factories — production-wise, and has nothing whatever to do with research and development of V1, V2 or nuclear energy.

Concerning hard work and efficient management, I have always found it better to remove as much physical effort from a job as possible to improve quantity and quality of production. "Hard graft" does not necessarily imply efficient management. As for rewards, I am glad (and so is Herr Wolff I imagine) that I did not have to live on the wages of a skilled man in Germany.

Herr Wolff seems to imply that I gave my impressions after living in a vacuum in Germany. As I mentioned above, I lived in a family household and discussed the German situation with many people, from senior executives to workmen. I am quite sure that many of my German friends — for I made friends too — would agree with my impressions, since they were the source of many of them.

Finally, may I compliment Herr Wolff on his letter in a foreign language. I wish I could reply in as good German as his English.

MINUTES OF THE EXTRAORDINARY GENERAL MEETING

HELD ON THURSDAY, 30th APRIL, 1959,

AT THE HEADQUARTERS OF THE INSTITUTION,

10 CHESTERFIELD STREET, MAYFAIR, LONDON, W.1.

THE CHAIRMAN (Mr. G. R. Pryor) apologised for the absence of the President, Lord Halsbury, who should have been in the Chair.

Memorandum of Association of the Institution

Mr. R. J. C. Whitaker moved:

"That the Memorandum of Association of the Institution be altered in accordance with the terms printed in the Notice of the Meeting."

Mr. L. W. Bailey seconded.

Mr. Gordon England congratulated the Council on a magnificent piece of work. He thought all the documents presented were a first-class effort.

The motion was carried nem con.

Articles of Association

The Chairman explained that it was essential when petitioning for a Royal Charter that the draft Charter should be substantially the same as the existing Memorandum of Association, and that the draft Bye-laws be substantially the same as the Articles of Association. Therefore, it was necessary to obtain the meeting's approval of the proposed alterations.

Mr. R. N. Marland moved:

"That the Articles of Association of the Institution be altered in accordance with the terms printed in the Notice of the Meeting subject to the correction of certain misprints which had been enumerated."

Mr. J. L. Gwyther seconded.

The motion was carried nem con.

Petitioners

The Chairman explained that Council considered it desirable that the Petition should be signed by the Past Presidents of the Institution, and those set out were the Past Presidents who were available and who had agreed to sign the Petition.

Mr. A. L. Stuchbery moved in accordance with the terms printed in the Notice of the Meeting:-

"That the Petitioners therein named (being members of the Council of the Institution) be authorised and requested to present on behalf of the Institution and its members the Petition submitted to this Meeting praying that Her Majesty may be graciously pleased to grant a Charter of Incorporation to incorporate a company incorporated by Her Majesty's Royal Charter to acquire and take over the assets and carry on the activities of the Institution in succession to the present Limited Company."

Mr. B. C. Harrison seconded.

The motion was carried nem con.

Subscriptions

Mr. H. W. Bowen (Chairman of Council) said that when the subscriptions were last increased, the Council took the view that membership subscriptions should not be more than absolutely necessary, since the anticipation of inflation was the main cause of inflation. However, the subsequent events proved that the Council's policy, although patriotic, was not in the best interests of the Institution. Within 12 months the Postmaster-General increased postage and telephone rates which absorbed almost the whole of the additional income.

The Institution in the United Kingdom was just making both ends meet with a very small margin, and the Council felt that that was not a business-like way to run the Institution, since it made no provision for the growth and expansion of the profession. It was the view of the Council and its Finance and General Purposes Committee that the Institution should budget annually for an excess of income over expenditure of a minimum of 10% of income, and the new subscription rates had been calculated to produce that additional revenue.

He accordingly moved:

"That with effect from 1st July, 1959, the entrance fees and annual subscriptions should be increased in accordance with the terms printed in the Notice of the Meeting."

Mr. J. V. Connolly seconded, stating that it was not in his view possible to run with any greater economy within the Institution than at present, because the budgetary control of finance and economy within the Institution compared more than favourably with any other he had ever seen.

Mr. R. H. S. Turner said that the Institution had been in contact with its members overseas regarding their feelings with respect to the proposed increase in subscription, and the first matter which came up was that any relief in income tax was not applicable to overseas members. Therefore, there was no softening of the blow as far as they were concerned. Secondly, in many instances the increase would mean that those members were paying a subscription which was in excess of that payable to other comparable institutions overseas. Thirdly, many of the overseas members lived in scattered and widely distributed areas where they were not able to participate in the functions and amenities of an Institution such as The Institution of Production Engineers; therefore, in his view those members should receive special consideration, primarily in view of the income tax position.

Therefore, he moved as an amendment :-

"provided that the increases in entrance fees and annual subscriptions shall not apply to members outside the United Kingdom until such time as the Council shall direct."

Mr. H. P. Mott seconded.

The amendment was carried nem con.

The motion as amended was carried nem con.

Mr. H. P. Mott moved:

"That this Meeting approves the draft Charter and Bye-laws submitted to the Meeting."

Mr. Taylor seconded.

The motion was carried nem con.

Mr. K. J. Hume moved that in accordance with the terms printed in the Notice of the Meeting :-

"That in the event of Her Majesty being graciously pleased to comply with the prayer to the said Petition a further Extraordinary General Meeting of the Institution shall forthwith be convened to pass Special Resolutions for the winding up of the Institution and for all the transfer of all the property of the Institution after satisfaction of all its debts and liabilities to the new corporation which will have been incorporated by Her Majesty's Charter."

Mr. Nicolson Low seconded.

The motion was carried nem con.

That concluded the business of the Extraordinary General Meeting, and the Chairman declared the proceedings terminated.

REPORT OF THE MEETING OF COUNCIL

30th APRIL, 1959

THE last Council Meeting of the 1958 - 1959 Session was held on Thursday, 30th April, 1959, at the Headquarters of the Institution, 10 Chesterfield Street, Mayfair, London, W.1, at 11 a.m. The Chairman of Council, Mr. H. W. Bowen, O.B.E., presided over the meeting which was attended by 29 Members. Also present, by invitation, were Mr. J. W. Taylor, Honorary Secretary, Southern Region; Mr. J. Nicolson Low, Honorary Secretary, Scottish Region; and Mr. H. Scholes, Chairman, Halifax and Huddersfield Graduate Section.

Election of Principal Officers, 1959 - 1960

The Chairman said it gave him great pleasure to move that Mr. G. Ronald Pryor be elected President of the Institution for the year commencing 1st July, 1959. Mr. Pryor had been a very good friend of the Institution for many years.

The motion was carried by acclamation.

Mr. Pryor, thanking the Council, said that he was most conscious of the honour which had been accorded him. He would certainly use his best endeavours to uphold the dignity of the Institution, although no one was more aware than he himself of the difficult job he would have in following Lord Halsbury.

The Chairman then moved that Mr. Harold Burke be elected Vice-President of the Institution. Mr. Burke had taken a leading part in the successful regionalisation of the Institution and had done a great deal of valuable work over many years.

The motion was carried by acclamation.

Mr. Pryor had much pleasure in moving that Mr. H. W. Bowen be elected Chairman of Council for a further year. All members of the Council had benefited from Mr. Bowen's Chairmanship during the current year, and were appreciative of the great amount of time he had spent travelling round the Sections.

The motion was seconded by Mr. Gregory, and carried by acclamation.

Thanking the Council, the Chairman said he would continue to do his utmost to uphold the best traditions of the Institution.

Mr. Gregory then moved that Mr. R. H. S. Turner be elected Vice-Chairman of Council for a

further year of office. Mr. Turner's handling of the "foreign affairs" of the Institution was well-known to members of Council, and also his work as Chairman of the Ad Hoc Committee on Investigation.

The motion was seconded by Mr. J. H. Winskill, and carried by acclamation.

Finance

A report on the Institution's finances was received by the Council, from which it appeared likely that the surplus of income over expenditure for the current year will slightly exceed the amount budgeted.

Institution Social Function

It was reported by the Finance and General Purposes Committee that a special Institution social function was being planned, to which members and their ladies would be invited. This would take the form of a Conversazione, to be held at the Royal Festival Hall, London, on Monday, 27th June, 1960.

Institution National Conference

The Council were informed that a national conference on "Modern Trends in the Manipulation of Metals" is to be held in Brighton in the Autumn of 1960. Papers given at this Conference will deal primarily with the technique of chipless forming, and the arrangements have been delegated to the Papers Committee, who proposed the subject.

Education

The Chairman of the Education Committee, Mr. J. France, reported that the Ministry of Education, Northern Ireland, had invited the Institution to participate in a tripartite committee comprising representatives of the Ministry, The Institution of Production Engineers and The Institution of Mechanical Engineers, in connection with the award of the Higher National Certificate in Production Engineering, for a course to start in 1959. The committee had now been set up in Belfast.

Referring to the 1959 Summer School, Mr. France said that the programme was now complete, and he was pleased to report that the incoming President, Mr. G. Ronald Pryor, had agreed to give the opening address.

Membership

The Council approved a number of applications for membership and transfer, details of which will be found on pages 411 - 412.

The Journal

It was reported that the Editorial Committee were now holding their final discussions on future Journal policy and would shortly present their recommendations to the Finance and General Purposes Committee.

The sale of advertising for the first three months of the year showed a slight increase over the same period last year, and every effort was being made to maintain this trend.

Institution Papers

The Papers Committee reported that the 1958 Viscount Nuffield Paper, presented at the University of Birmingham in March, 1959, had been a most successful and well-attended meeting. A full report appears in the May issue of the Journal.

The 1959 George Bray Memorial Lecture would be presented in London, early in 1960, by Mr. C. H. Bulmer, of the Printing, Packaging and Allied Trades Research Association, on the subject of "Packaging of Engineering Products".

The 1959 Viscount Nuffield Paper would be presented in Glasgow, on 17th March, 1960, by Dr. C. Timms, M.I.Prod.E., of the Mechanical Engineering Research Laboratories.

Research

The following reports were made on behalf of the Research Committee :-

Materials Handling Group. The Group Committee are at present considering ways and means of increasing the Group activities in the Sections, and it is hoped to announce detailed plans shortly. Discussion in the Building Research Station on the co-operation necessary between the architect and the production engineer, when building a factory, is continuing.

Materials Utilisation. The Committee's Report was now in the final stages and publication was planned for September, 1959.

Control of Quality. The Committee were primarily occupied with the planning and administration for the "Quality in Industry" Conference to be held in Buxton on 18th - 19th June, 1959.

Standardisation

It was reported that the Standards Committee were progressing with its work of reading and preparing comments on the implementation of International Standards Recommendations.

The Joint I.Prod.E./B.S.I. Standing Advisory Committee on the Use of Standards in Industry had been engaged in the planning of the Fifth Annual Conference for Standards Engineers, which was arranged to take place on 4th June, 1959. Lord Halsbury was to be the opening speaker.

In addition, the Committee continued to maintain active liaison with the National Joint Committe on Non-Destructive Testing; the British Institute of Management; and the British Productivity Council.

Region and Section Quarterly Reports

The Council received a number of Region and Section Quarterly Reports.

Examination and Exemption Fees

The Council adopted the recommendation made by the Finance and General Purposes Committee that the Institution examination and entrance fees be increased from 1st July, 1959, as follows :-

Part I(a)	£5 5s. 0d.
Part I(a) and I(b) ...	£6 6s. 0d. Individual subjects £1 1s. 0d. each
Part II	£5 5s. 0d. Individual subjects £1 11s. 6d. each
Part III	£5 5s. 0d. Individual subjects £2 2s. 0d. each
Exemption Fees ...	£1 1s. 0d. for any Part or part of a Part
Thesis Fee	£7 7s. 0d.

Obituary

The Council learned with deep regret of the deaths of the following members :-

Members : H. H. Whitaker; C. Reid; F. H. J. Mills; Sir Claude Gibb; I. F. E. Hollins; E. T. Cook; S. Bottams; W. A. Harris; A. Lowe; R. H. Mead; R. H. Clark; G. W. Corkindale.

Associate Members : H. Matthews; J. E. W. Youston; A. Mort; H. Lilley; J. J. Bowley; R. Leather; D. Dewhurst; J. Brook; E. Shackleton.

Affiliated Representative : J. R. Greenwood (Craven Bros. (Manchester) Ltd.).

Date and Place of Next Meeting

It was agreed that the next meeting of the Council should take place on Thursday, 23rd July, 1959, at 11 a.m., at 10 Chesterfield Street, Mayfair, London, W.1.

ELECTIONS AND TRANSFERS

30th APRIL, 1959

BIRMINGHAM SECTION

As Associate Members
H. J. Ellis; P. P. Williams; P. J. Sproat; G. A. Grady; J. C. W. Hall.

As Associates
C. V. Dolphin; E. Foster.

As Graduates
J. H. Terry; J. G. Sewell; J. Riley; M. H. Goodwin; J. H. Ilsley; R. E. Brown; R. S. Langdon; M. L. Styles; D. W. G. Hall; J. M. Khanna.

As Students
F. G. Cooper; R. G. Keogh; B. C. Clarke; H. J. Pedley; J. D. Clutton; B. B. Slater; R. A. Homer; J. A. Kenney; A. H. Smith; L. A. Griffiths; C. Rone-Clarke.

Transfers

From Graduates to Associate Members
L. J. Allen; G. W. Payne; R. B. Mills; R. R. Walford; T. B. Willcox; J. G. Lowe; A. D. Riley; J. A. Walford; J. A. Fowler; R. Armstrong; H. W. Williams; G. A. D. Coghlan.

From Students to Graduates
G. B. Whitmarsh; J. F. Aston; K. J. Gray; C. R. Mortimore; R. C. Blythe; C. F. Smith.

BOMBAY SECTION

As Associate Member
D. N. Rakhra.

As Graduates
B. S. Ganesh; M. K. Bhandari; M. H. Pherwani; N. N. Ghulati.

As Students
B. M. Sen; R. Chopra; S. K. Mondal.

CALCUTTA SECTION

As Graduates
R. K. Bathla; B. Sen; A. K. Ahluwalia; W. C. Zahn; A. D. Gupta.

As Students
O. P. Kataria; C. Singh.

CANADA SECTION

As Associate Member
R. J. Rainey.

Transfer

From Student to Graduate
M. A. Crisford.

CARDIFF SECTION

As Graduates
D. Williams; P. C. Davies; B. F. Shelly; W. Davies; D. E. McMahon; D. Evans.

As Students
J. G. Thomas; B. T. Lapping; L. H. Parsons; J. L. Heather; P. R. Rogers; P. A. Thomas; L. H. Belcher.

Transfers

From Graduate to Associate
B. P. Hague.

From Student to Graduate
S. Taylor.

CORNWALL SECTION

As Associate
C. S. Smith.

COVENTRY SECTION

As Associate Member
H. Allen.

As Graduates
R. T. Collett; A. W. Picken; D. J. Amery; D. Millward; P. L. Batty.

As Student
D. J. Knight.

Transfers

From Graduates to Associate Members
P. A. Mason; D. W. Ashmore.

From Students to Graduates
A. J. Segrave; C. Austin; M. J. Chaston; C. H. Garner.

DERBY SECTION

As Member
G. R. Brown.

As Associate Member
A. G. Ottewell.

As Graduates
W. G. Wood; D. W. Parr; G. E. Mallett.

As Students
R. H. Astill; N. Key.

Transfers

From Associate Member to Member
F. Caldwell.

From Graduates to Associate Members
H. R. Harwood; B. H. Garrett; R. Rowland.

From Students to Graduates
B. Fielden; W. Whittaker; R. Thornhill; J. E. Priestman.

DONCASTER SECTION

As Graduate
J. M. G. Tomlinson.

Transfer

From Student to Graduate
D. Strawbridge.

DUNDEE SECTION

As Associate Member
R. M. Douglas.

As Graduate
R. D. Elliot.

As Student
J. M. Brown.

Transfer

From Graduate to Associate Member
J. Norrie.

GLASGOW SECTION

As Member
R. C. Hockey.

As Associate Members
K. V. Thomason; D. Sharkie.

As Graduates
J. M. Allardice; J. Scott.

As Students
G. M. Hoskins; R. J. M. Fisher; W. Telfer; A. B. L. Wu; J. Mitchell; C. S. Murray; A. McDougall; P. F. J. Gallagher; R. J. Morrison.

Transfers

From Graduates to Associate Members
R. A. R. Coutts; W. M. Cairns; J. Thomson; L. F. G. Walker.

GLOUCESTER SECTION

As Graduates
G. W. Strudwick; J. R. Ruck.

As Students
P. D. Ounsworth; B. D. Steel; J. L. Sweetman.

Transfer

From Graduate to Associate Member
C. L. Brett.

HALIFAX & HUDDERSFIELD SECTION

Transfers

From Graduates to Associate Members
H. Scholes; R. Dixon.

IPSWICH SECTION

As Students
R. M. Fulcher; J. Hughes; J. R. Lawes.

LEEDS SECTION

As Associate Members
F. W. Kingston; A. E. G. Day.

As Student
J. C. Boulton.

Transfers

From Graduates to Associate Members
J. B. Clayton; J. Keightley.

From Student to Graduate
W. P. Barker.

LEICESTER SECTION
As Associate Member
K. H. G. Doughty.
As Graduates
S. E. Partridge; S. Kumar; H. L. King; P. J. Richmond; L. Guy; B. Bancroft.
As Students
J. W. Cunnington; J. Bird; M. E. Partridge.
Transfers
From Graduates to Associate Members
A. Garner; C. H. Wright; P. L. Cross; C. Allen; D. G. J. Swinfield.
From Students to Graduates
I. H. Jung; M. P. Yates; B. K. Hollingworth.

LINCOLN SECTION
As Graduate
S. M. Cartwright.
As Student
D. A. Richards.
Transfer
From Graduate to Associate Member
L Hackney.

LIVERPOOL SECTION
As Graduates
R. Graham; R. Griffiths; D. S. Deshpande; B. J. Cave.
As Student
P. L. Jones.
Transfers
From Graduates to Associate Members
N. Whitehead; G. S. Sheppard; W. G. Hearle.
From Student to Graduate
J. Grimshaw.

LONDON SECTION
As Associate Members
A. Feibusch; A. J. Weller; V. F. G. Hudson; W. C. Tuck; J. M. Alexander; P. Wilson; J. C. Williams.
As Associate
J. W. Grant.
As Graduates
D. B. Fielden; R. E. Harman; K. Francis; D. J. Goodley; J. B. Porter; A. I. Cooper; I. A. G. Powell; M. R. H. Saunders; P. M. Cockman; G. H. Haith; A. Aziz; W. S. Morrow; J. Foxcroft; D. R. Jones; M. A. S. Burt.
As Students
A. R. Levett; T. K. Wong; H. M. Bone; R. W. J. Peggs; B. L. Bowbrick; E. R. Seal; L. V. Bonifas; L. R. London; J. E. Rogers; K. H. Williams; J. A. Neate; D. Brewer; C. P. Bettaccini; E. F. Planken-Bichler; R. A. C. Dandy; J. M. Leader; B. L. Waine; J. P. Brennan; J. H. Armour; D A Royal; A. J. Powell; W. B. Catmur; J. E. Fisher.
Transfers
From Associate Members to Members
W. Hird; J. G. Lloyd.
From Graduates to Associate Members
D. Nicod; J. P. Dainty; D. J. Jerrard; R. G. Powell; D. E. Jarvis; A. D. Davies; J. M. Gardner; L. J. Harrow; K. G. H. Williams; D. B. Richardson.
From Students to Graduates
N. Ahmad; R. E. Finch; V. N. Manchee; A. E. Hayllar.

LUTON SECTION
As Associate Members
G. Weisz; O. W. Dokk-Olsen.
As Associate
C. J. M. Benard.
As Graduates
J. M. Wilson; L. W. Midgley; A. W. Hart; A. A. F. Peters; J. B. Piggott; R. D. R. Brown; G. R. Jefferys.
As Students
D. S. Edgar; J. F. Gordon; M. J. Bright.
Transfers
From Associate Member to Member
G. Kelly.
From Graduate to Associate Member
D. E. Mack.
From Students to Graduates
R. R. Wiltshire; R. E. Mynott.

MANCHESTER SECTION
As Member
H. L. Bunce-Christy.
As Associate Members
H. J. Baker; R. Conway.
As Graduates
A. S. Willcox; D. N. Ratcliffe; B. Thorp; J. A. Ladley.
As Students
B. L. Varshney; P. Metcalfe; R. Turner; I. R. Harty; D. T. Smith; S. S. Gogia; D. Wilde.
Transfers
From Associate Member to Member
H. O. Pate.

From Graduates to Associate Members
R. A. Jones; L. E. Chadderton; W. Lord; G. A. Bray.
From Student to Graduate
G. Hall.

MELBOURNE SECTION
As Associate Member
K. F. Nicklin.

NEWCASTLE UPON TYNE SECTION
As Student
J. D. Rennison.
Transfers
From Graduate to Associate Member
G. R. T. Cummings.
From Student to Graduate
G. Urwin.

NORWICH SECTION
As Student
M. E. Wakefield.

NORTHERN IRELAND SECTION
As Associate Member
W. H. Bell.

NOTTINGHAM SECTION
As Graduates
R. L. Streets; P. Butler; B. Crooks.
As Student
J. G. Loveday.
Transfers
From Associate Member to Member
W. R. Vaughan.
From Graduate to Associate Member
T. E. A. Dicken.
From Student to Graduate
R. L. Sunderland.

OXFORD SECTION
As Graduate
J. R. Marsh.
As Student
R. El-Mikaati.
Transfers
From Graduates to Associate Members
G. N. Iley; J. Sparrowhawk; P. S. Dunford.
From Students to Graduates
D. W. Hicks; G. E. Perkins; D. J. Smith.

PETERBOROUGH SECTION
As Associate Member
R. B. Petrie.
As Graduate
G. U. Ahmed

PRESTON SECTION
As Associate Members
G. H. Taylor; J. C. Slater.
As Graduates
C. Ethrington; J. E. Eaton; R. Greenwood; K. Grant.
As Students
G. Coleclough; E. Smallman; B. Fletcher; J. Edmondson.
Transfers
From Graduates to Associate Members
F. E. Farnworth; W. H. Sutton; J. Abbott; J. Harwood; W. S. Hasler; A. Wilkinson.
From Students to Graduates
A. A. Hardisty; F. Barker; A. Spence.

READING SECTION
As Associate Members
J. M. S. Hart; D. Rodgers, M.B.E., B.E.M.
As Graduates
W. R. McConnell; C. R. Campbell; R. Down; K. G. McCarthy.
As Students
J. Gifford; R. A. Wyles; A. R. Stephenson.
Transfers
From Graduate to Associate Member
E. R. Marshall.
From Student to Graduate
A. R. Stevens.

ROCHESTER SECTION
As Student
M. G. Brotherhood.
Transfers
From Students to Graduates
F. E. White; J. W. Browning.

SHEFFIELD SECTION
As Member
P. Turrell.
Transfers
From Associate Member to Member
F. A. Bailey.
From Graduates to Associate Members
P. C. Grigg; D. R. Wilson; R. Horsley; E. Willcox.
From Students to Graduates
R. Batty; B. Hibberd.

SHREWSBURY SECTION
As Associate Member
J. Griffiths.
Transfer
From Student to Graduate
M. J. Parker.

SOUTH AFRICA SECTION
As Graduates
W. P. Venter; F. P. Zeigler.

SOUTH ESSEX SECTION
As Associate Member
C. Jackson.
As Graduates
G. E. Wright; P. J. Moorse; R. P. Pardy; J. H. Smith; M. Bowes; D. W. Ellis; C. M. J. Watkins; A. Evans.
As Students
L. W. Willis; R. Salmon; M. J. Harden; P. West; D. A. Warner.
Transfers
From Students to Graduates
A. Dines; D. G. Melven; B. E. Maltwood.

SOUTHAMPTON SECTION
As Associate
A. D. Brown.
As Graduates
D. M. M. Rutherford; A. J. Mathews.
As Students
C. A. Hutchins; F. Graham; D. Higbee.
Transfers
From Students to Graduates
P. A. Ross; P. W. Wilkinson.

STOKE-ON-TRENT SECTION
As Graduate
S. Barlow.

SWANSEA SECTION
Transfer
From Graduate to Associate Member
J. Y. Gardner.

SYDNEY SECTION
As Member
R. L. Barbour.
As Associate Member
R. Davies.
As Graduate
A. R. Darch.
As Students
C. F. Hitchen; W. G. Fox.
Transfers
From Graduates to Associate Members
W. H. Landmann; J. E. Slade.

TEES-SIDE SECTION
As Associate Member
E. Jopling
As Graduates
T. Sowerby; F. W. Pateman; P. G. Rhodes; D. Dixon; R. A. Thompson.

WESTERN SECTION
As Graduates
J. B. Talbot; M. Blades.
As Students
K. M. Charlton; P. J. Pothecary.
Transfers
From Graduates to Associate Members
G. L. Ball; G. D. Slegg.

WOLVERHAMPTON SECTION
As Graduates
B. H. Porter; E. Dodd; L. E. Ramsbottom; A. T. Owen; D. H. Wells; K. E. Robbins; R. Kerry; D. Mason; C. J. Cartwright.
As Students
A. J. Braddock; L. T. Wynne; D. N. Byard.
Transfers
From Graduates to Associate Members
A. M. Pritchard; C. F. Johnson; S. T. Pitt; H. M. Harvey; A. Boyce.
From Students to Graduates
R. W. J. Hutton; A. J. Smith.

WORCESTER SECTION
As Graduates
A. J. Davies; E. H. Richards.
Transfers
From Associate Member to Member
A. C. Hubble.
From Students to Graduates
E. J. Wallis; K. F. Tye; J. Sullivan.

NO SECTION
As Associate Member
P. Faulkner.
As Graduates
M. A. Khan; R. J. Parker.
Transfers
From Graduates to Associate Members
T. Roberts; D. P. Mortimer.
From Students to Graduates
D. S. Vaidya; H. Harb.

This would establish standard practice which could be applied in principle to a much wider field. Then engineering intuition was at least guided into the broad areas for which it was most likely to be appropriate.

The **Chairman** said that it remained for him, on behalf of the Institution, to thank Mr. Bogod for his most stimulating Paper and his very expert handling of the questions. He had necessarily dealt with the Paper in a much briefer form than in the text, and there were many interesting points in the text which would well repay study and on which he would have liked Mr. Bogod to elaborate a little more. For instance, he was astonished to find that when conclusions were reached about the new plant, it could not be put into operation for two years because they had to get the law altered! That might be a very useful accomplishment; at a later date perhaps Mr. Bogod could give some tips about it. He would like derating restored and initial allowances and investment allowances made a bit more stable, and when they were not favourable altered to the more favourable sort.

On behalf of everybody present he thanked Mr. Bogod very much indeed. (Applause.)

The meeting then terminated.

INTERNATIONAL CONFERENCE ON HEAT TRANSFER

The Institution of Mechanical Engineers, jointly with the American Society of Mechanical Engineers, is planning to hold a Conference on Heat Transfer, in the United States in August, 1961, and in Britain in 1962.

It is hoped to obtain about 100 short Papers on all aspects of heat transfer, which will be presented and discussed on both sides of the Atlantic.

Further details of the arrangements will be announced as they become available.

DIARY DATES FOR 1959

August 26th - 30th ... **Summer School, Ashorne Hill.** (See Supplement to this Journal.)
Theme: **"Management Staff Education, Selection and Training."**

September 24th - 25th **Eastern Regional Conference, Norwich.** (See Supplement to this Journal.)
Theme: **"Production Engineering as a Function of Management."**

October 12th ... ... **The 1959 E. W. Hancock Paper,** to be presented in Bristol.
Speaker: **Mr. R. A. Banks,** Personnel Director, Imperial Chemical Industries Limited.
Subject: **"Human Relations in Industry."**

November 19th ... **The Annual Dinner,** Dorchester Hotel, London, W.1.

THE PRESIDENT

The election to Presidential office of **Mr. G. Ronald Pryor** *will give immense pleasure and satisfaction to the membership of the Institution. The award of the highest honour that the Council can bestow is a fitting tribute to a man who has worked untiringly, and with notable success, for the advancement of the Institution and the profession of production engineering.*

His activities on behalf of the Institution have been so widespread that it is possible here to refer only briefly to some of his major achievements. He has served on the Council continuously since 1945, and was Chairman from 1954 - 1956. He was formerly Vice-Chairman, in which capacity he completed the major task of drawing up new Articles of Association, which were adopted in January, 1954. He has also been a member of the Finance and General Purposes Committee since 1947.

In 1956, he led the U.K. Delegation to the Delft Conference, initiated by the Institution, on Teaching of Production Engineering at University Level, and was Chairman of the Conference. In 1958, jointly with Mr. J. E. Hill, Mr. Pryor headed the Institution's delegation to Poland.

He takes a keen interest in production engineering research, and has served on the Council of the Production Engineering Research Association of Great Britain since 1950, and on the Executive Committee of this body since 1951.

Mr. Pryor was born in 1901, and educated at Wellington College, Salop. In 1919, he was apprenticed to the family firm of Edward Pryor & Son Ltd., of Sheffield, which was founded in 1843, and of which Company he is now the Chairman and Managing Director. He is also Chairman of Punch Forgers Ltd., of Sheffield.

Sheffield has always claimed a major share of Mr. Pryor's time, and he is actively concerned with business and industrial interests there, where he is a well-known and widely respected figure. He is a Past President of the Sheffield Section of the Institution, and also a past Chairman of the Sheffield Section of the Institute of Industrial Administration, of which body he was elected a Fellow. He has served on the Council of the Sheffield Chamber of Commerce since 1951, and was subsequently appointed Vice-Chairman of the Education Committee of the Chamber.

He is a man of very wide interests and among his hobbies are beagling, sailing, ornithology and photography. He also enjoys travelling and has visited most European countries, Canada and the United States.

PAL OFFICERS, 1959-60

THE CHAIRMAN OF COUNCIL

Mr. H. W. Bowen, O.B.E., *the present Chairman of Council, has been re-elected for a further year of office. Mr. Bowen has taken a leading part in the activities and development of the Institution since he became a member in 1934, and during the past year has visited many Sections throughout the United Kingdom.*

Mr. Bowen, who is now Chairman of Damic Controls Ltd., Uxbridge, has had a spectacular career in industry. Following service as a Flying Officer in the Royal Flying Corps in the First World War, and an apprenticeship with the Montreal Water and Power Company, he joined the Canadian Electric Steel Company in Montreal as a mechanical draughtsman, subsequently moving to the Hall Engineering Company, Montreal, as Chief Draughtsman. He returned to the United Kingdom in 1923, and became Production Engineer with W. T. Glover, of Manchester.

Following similar positions with British Celanese Ltd., Derby, and the Ford Motor Company, in 1933 Mr. Bowen accepted an important appointment with Vickers-Armstrongs Ltd., at Barrow-in-Furness. He remained at Barrow until 1940, when he joined E.M.I. Factories Ltd., Hayes, as Joint General Manager (later Managing Director).

He left E.M.I. in 1953 to become Managing Director of High Pressure Components Ltd., West Drayton, and remained there until 1957, when he established the Company of which he is now Chairman.

In addition to serving on the Institution's Council, Mr. Bowen is a Past President of the London Section; has served on the Education Committee; and was Chairman of the Programme Committee for the Institution's Conference at Harrogate in 1957. He is also a Member of The Institution of Mechanical Engineers, and a Gold and Silver Medallist of the Junior Institution of Engineers.

THE VICE-CHAIRMAN OF COUNCIL

Mr. R. H. S. Turner, M.A.(Cantab), *has been re-elected for a further year of office as Vice-Chairman of Council. Mr. Turner is Director and Works Manager of Metropolitan-Vickers Electrical Co. Ltd., Manchester.*

The Principal Officers take office as from 1st July, 1959.

institution notes

BIRTHDAY HONOURS

The Institution warmly congratulates the following Members, who have been honoured by Her Majesty the Queen :-

Knight Bachelor

James Pearson, Member, Deputy Chairman, Vauxhall Motors Ltd.

C.B.

R. Ratcliffe, M.B.E., Member, Deputy Controller of Royal Ordnance Factories, Ministry of Supply. Mr. Ratcliffe is a Past Chairman of the Institution's Education Committee.

M.B.E.

E. Wheeldon, Member, Managing Director, Westland Aircraft Ltd.

THE COLLEGE OF TECHNOLOGISTS

The establishment of The College of Technologists was recently announced by the Governing Body of the National Council for Technological Awards.

The College will administer the award of Membership of The College of Technologists (M.C.T.) which the National Council propose to create as a qualification higher than the Diploma in Technology. The College will operate within the framework of the National Council for Technological Awards and will be served by the same administrative staff.

A Board of Scientific and Industrial Studies is to be responsible for the academic and industrial aspects of the administration of the award. The Chairman is to be Sir Arnold Hall, Managing Director, Bristol Siddeley Engines Ltd., and among other appointments to the Board is that of **Mr. A. W. J. Chisholm,** A.M.I.Prod.E., Head of the Department of Mechanical Engineering, Royal Technical College, Salford; and **Sir Stanley Harley,** M.I.Prod.E., Managing Director, Coventry Gauge & Tool Co. Ltd.

TENTH ANNUAL SUMMER SCHOOL, 1959

Arrangements have now been completed for the Institution's 10th Annual Summer School, which is to take place at Ashorne Hill, Leamington Spa, from Wednesday, 26th August, to Sunday, 30th August. Full details, together with an application form, appear in the Supplement to this month's Journal.

The Conference theme is "Management Staff Education, Selection and Training", and the Institution has been fortunate in obtaining a number of authoritative speakers to deal with all aspects of this theme. The opening address will be given by **Mr. G. Ronald Pryor,** President of the Institution, and it is anticipated that the Conference will not only add to existing knowledge on this important subject, but will also provide an opportunity for useful discussion between individuals concerned with all aspects of management staff education, selection and training.

Left: Mr. E. W. Hughes, Organiser of Research, Institute of Education, University of Leicester, who is to speak in the session on "Education".

Centre: The other speaker in this session will be Mr. P. B. R. Gibson, Deputy Director, Sundridge Park Management Centre.

Right: Mr. E. R. L. Lewis, Controller of Education with The English Electric Group of Companies, who is one of the speakers in the session on "Training".

IMPORTANT NOTICE

The 1960 Associate Membership Examination Date of Entry for the Examinations

The attention of candidates is drawn to the fact that for those taking Part I subjects the Institution is now a participant in the Engineering Institutions' Examination Committee for Part I, which Committee (and not this Institution) will conduct the examinations in the subjects of :-

English	Engineering Drawing
Mathematics	Heat, Light and Sound
Applied Mechanics	Principles of Electricity

This block of subjects will be designated as Part I(a), leaving the additional subject of Production Processes or Chemistry to be examined by the Institution and designated Part I(b).

Apart from the fees payable, the procedure for Parts I(b), II and III, the papers for which will be set by this Institution, remains unaltered.

The examination, however, for Part I(a) is held twice a year (usually the second week in April and October) at Home Centres; for Overseas Centres the Northern Hemisphere — April; and the Southern Hemisphere in October.

The final date for receiving applications to attend the examination for Part I(a) are as follows :-

Candidates attending at	*April Examinations*	*October Examinations*
Home Centres ...	15th February	15th August
Overseas Centres	Northern Hemisphere — Previous 15th November	Southern Hemisphere–15th May. at New Zealand, 15th January at Auckland.

Applications for Parts I(b), II and III remains at 1st April. The booklet, Membership Regulations, has been reprinted and gives full details of examination procedure. This, together with application forms for Parts I(b), II and III, can be obtained on application from the Registrar at 10 Chesterfield Street, Mayfair, London, W.1.

CORRESPONDENCE

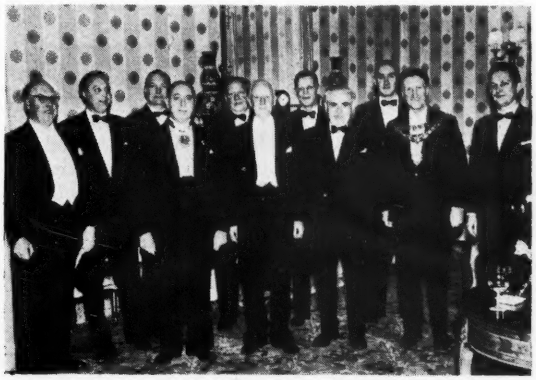
Written discussion on Papers appearing in the Journal is invited for publication. Contributions should be addressed to :-

The Editor,
The Journal,
10 Chesterfield Street, Mayfair, London, W.1.

NORTH WESTERN REGIONAL DINNER

The North Western Regional Committee of the Institution held their fifth Annual Dinner on Friday, 24th April, 1959, in the Derby Suite of the Midland Hotel, Manchester. One hundred guests and members were present, and in the group photographed below are the distinguished guests with their hosts.

The toast to "The Queen" was proposed by Mr. Speakman, and Mr. Stoddart proposed the toast to "The Guests" to which Alderman Lever responded. The Institution toast was proposed by Mr. Jones and the Chairman of Council responded.



From left to right: **Mr. J. H. Winskill, Member of Council; Mr. S. Caselton, Deputy Secretary of the Institution; Mr. W. F. S. Woodford, Secretary of the Institution; The Rt. Worshipful the Deputy Mayor of Manchester, Alderman Leslie Lever, J.P.; Mr. J. H. Jones, M.P.; Mr. T. A. Stoddart, Regional Chairman; Mr. R. H. S. Turner, Vice-Chairman of Council; Mr. H. W. Bowen, O.B.E., Chairman of Council; Mr. R. S. Clark, Regional Committee; The Worshipful the Mayor of Prestwich, Councillor J. A. Crofton, J.P.; and Mr. J. P. Speakman, Regional Honorary Secretary.**

MEMBERS TRAVELLING OUTSIDE THE UNITED KINGDOM

Members who are visiting Australia, New Zealand, India, South Africa or Canada, are reminded that the Institution has local Sections in these countries, where they will be made very welcome by the Institution's Honorary Officers and members there.

Papers on subjects of interest to production engineers and managers are always welcomed, and any members who are visiting one of the Sections outside the U.K., and who would like letters of introduction, should inform the Secretary of the Institution at 10 Chesterfield Street, Mayfair, London, W.1.

news of members

The Rt. Hon. the Earl of Halsbury, F.R.I.C., F.Inst.P., Member, has been appointed to the board as Chairman of Lancashire Dynamo Electronic Products. Lord Halsbury is already Vice-Chairman of the parent Company, Lancashire Dynamo Holdings.

Mr. W. Hirst, Member, General Manager of the Gear Division of Messrs. George Angus & Co. Ltd., has been elected Vice-Chairman of the British Gear Manufacturers Association.

Mr. W. A. Smyth, Member, has been appointed Works Consultant to G. K. N. Group Services Ltd.

Mr. V. J. Adams, Associate Member, has recently relinquished his position of Works Manager of Birmingham Sound Reproducers, Old Hill, and has now joined Messrs. Fisher & Ludlow Ltd., Albion Works, as Manager (Production), Domestic Appliances Division.

Mr. George Butler, Associate Member, who was recently appointed to the Board of The Butler Machine Tool Company, is at present in Australia at the Machine Tool Exhibition in Sydney. Mr. Butler has been elected Vice-Chairman of the Halifax and Huddersfield Section for 1959 - 1960.

Mr. K. E. Gregory, Associate Member, has relinquished his position with the Brightside Foundry & Engineering Co. Ltd., and has recently taken up an appointment as Assistant Works Manager in the Engineering Department of Edgar Allen & Co. Ltd.

Mr. H. J. Hammill, Associate Member, has taken up an appointment as Managing Director of John Morris Electrical Engineering Ltd., Bilston, Staffs. He was previously Managing Director of Foster Transformers Ltd., London.

Mr. J. Mackle, Associate Member, has been elected President of the Scottish Road Passenger Transport Association.

Mr. G. T. Price, Associate Member, has recently relinquished his position as General Production Manager of Vono Ltd., Tipton, and has taken up an appointment as Works Manager of Henry Hope & Sons Ltd., Smethwick.

Mr. R. W. Ransome, Associate Member, has recently returned from Australia and has taken up an appointment as Works Manager of Airbri Engineers Ltd., New Addington.

Mr. A. W. Thompson, Associate Member, has been appointed Vice-Principal of Paddington Technical College.

FOUR MEMBERS ON NEW BOARD

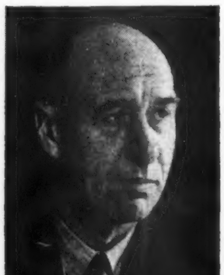
Four Members of the Institution are concerned in appointments to the new Board of Directors of Kitchen & Wade Ltd. and Ormerod Shapers Ltd. They are **Mr. Robert W. Asquith,** M.I.Prod.E., who is Chairman of both Companies; **Mr. W. A. Hannaby,** M.I.Prod.E., Managing Director of Kitchen & Wade Ltd. and Director of Ormerod Shapers Ltd.; **Mr. George Wright,** M.I.Prod.E., and **Mr. John Blakiston,** M.I.Prod.E., Directors of Kitchen & Wade Ltd.

Mr. Hannaby and Mr. Blakiston are both Past Chairmen of the Halifax and Huddersfield Section of the Institution, and Mr. Wright is Past Chairman of the Bristol Section; all have served on the Council of the Institution.

Mr. R. W. Asquith

Mr. J. Blakiston

Mr. W. A. Hannaby



Mr. G. W. Wright

Mr. W. Tindale, Associate Member, has relinquished his position as Assistant Works Manager with Eimco (G.B.) Ltd., Gateshead, and has taken up an appointment as Assistant Works Manager with Lightfoot Refrigeration Co. Ltd., Wembley, Middx.

Mr. T. C. Winmill, Associate Member, Production Engineer with Stein Atkinson Vickers Hydraulics Ltd., Chessington, Surrey, has been appointed Works Manager of that Company's subsidiary works at South Nuffield, Redhill, Surrey.

Mr. W. C. D. Blower, Graduate, has taken up a position as Combustion Engineer with Mitchell Engineering Ltd., Peterborough.

Mr. J. Sainsbury, Graduate, has left Messrs. Henry Hope & Sons Ltd., Smethwick, and has taken up the position of Production Executive with G.E.C. Ltd., Erith.

Mr. A. Salt, Graduate, has relinquished his position as Assistant Chief Methods Engineer with Messrs. Hayward Tyler & Co. Ltd., Luton, and is now Chief Production Engineer with Blackburn Engines Ltd., Brough, Yorkshire.

Mr. R. K. Sikka, Graduate, has been appointed Planning Engineer in The Hindustan Motors, Uttarpara, near Calcutta.

Mr. D. S. Townsend, Graduate, has relinquished his position with Vauxhall Motors Ltd., and has taken up an appointment as Planning Engineer with A.E.I. — Hotpoint Ltd., Peterborough.

Mr. R. W. Wall, Graduate, has been elected to the Bristol City Council. Mr. Wall is a member of the Bristol Graduate Section Committee, was founder Chairman in 1951, was re-elected Chairman in 1953, and served as Honorary Secretary in 1945 and 1955.

OBITUARY

Mr. Charles Stanley Noble, M.I.Prod.E., died on 15th April, 1959, after a short illness, at the age of 65, and the Newcastle Section of The Institution of Production Engineers suffered the loss of one of its most active workers. Mr. Noble had been on the Section Committee for many years, and was Section Chairman (1944 - 1945). In 1957, he presented the Section with a medallion to be worn by the Chairman at any function of the Institution.

Mr. Noble served his apprenticeship with Messrs. Noble & Lund Ltd., and after distinguishing himself in the design, production and application of machine tools, was appointed a Director of the Company in 1927, and Joint Managing Director in 1952. During his 48 years' service with the Company, he became widely known in engineering circles and his loss will be keenly felt by the many engineers with whom he had such pleasant associations.

The Institution of Production Engineers and other organisations in which he was interested will miss the help and assistance which was so gladly and freely given on all occasions.

COUNCIL ELECTIONS, 1959-60

As a result of the Ballot, the following members have been elected to serve on Council for the year 1959 - 1960 :-

Members :

C. T. Butler	J. France	H. Unsworth
N. A. Dudley	S. G. E. Nash	G. A. J. Witton
B. H. Dyson	J. S. Silver	

Associate Member :

R. S. Clark

The total number of Ballot Papers returned this year was 1,313, compared with 1,317 last year. There were 6,059 Corporate Members eligible to vote.

Hazleton Memorial Library

ADDITIONS

Members are reminded of the following Library rule, which is frequently ignored:

"The initial loan period is one month, and borrowers may keep books and periodicals for further periods of one month, if they ask the Librarian, and if no other borrower wants them. Applications for renewal may be made by post or telephone."

Allan, D. H. W. **"Statistical Quality Control."** An introduction for management. *New York, Reinhold; London, Chapman and Hall,* 1959. 128 *pages. Graphs.* 28s.

Written for the manager who wishes to become familiar with statistical quality control without the necessity of considering the mathematical details of the technique. Contents: Statistical quality control objectives — Statistical quality control in the organisation — Some elementary statistical concepts — Process capabilities — Statistical control charts — Statistical acceptance sampling — Statistical methods for investigation and experimentation — Sources of quality control information (i.e., a bibliography).

Ashby, Sir Eric. **"Technology and the Academics."** An essay on universities and the scientific revolution. *London, Macmillan,* 1958. 118 *pages.* 15s.

Sir Eric Ashby is President and Vice-Chancellor of the Queen's University, Belfast. In this book he traces the history of technological education in the universities since the middle of the 19th century, and puts in a plea for the inclusion of technology in a liberal education, giving a comprehensive proposed syllabus for such an education.

Bernhardt, Ernest C. (editor). **"Processing of Thermoplastic Materials."** *New York, Reinhold; London, Chapman and Hall,* 1959. 690 *pages. Illustrated. Diagrams.* £7 6s. 0d. (Plastics Engineering Series of the Society of Plastics Engineers.)

This is the second of a series by members of the Society of Plastics Engineers (the first was "Quality Control for Plastics Engineers"). It reviews the engineering fundamentals on which the design of plastics processing equipment is based, and demonstrates the practical application of these fundamental concepts in the analysis of thermoplastic processing problems. It is designed to help fill the need for a basic textbook on the processing of thermoplastics. It is written for engineers, but does not require the reader to have previous specialised knowledge of plastics processing technology. Contents: Flow behaviour of thermoplastics (A. B. Metzer) — Heat transfer and thermodynamics (J. M. McKelvey) — Mixing and dispersing (W. D. Mohr) — Extrusion (J. P. Paton, P. H. Squires, W. H. Darnell, F. M. Cash and J. F. Carley) — Injection moulding (G. B. Thayer, J. W. Mighton, R. B. Dahl and C. E. Beyer) — Calendering (D. I. Marshall) — Mixing and dispersing processes (J. T. Bergen) — Sheet forming (N. Platzer) — Forming of hollow articles (G. B. Kovach) — Sealing and welding of thermoplastics (B. P. Rouse and T. M. Hearst) — Processing properties (R. F. Westover).

Chapman, W. A. J. **"Workshop Technology. Part I — An Introductory Course."** (3rd edition.) *London, Edward Arnold (Publishers),* 1959. 311 *pages. Illustrated. Diagrams.* 15s.

This standard textbook was first published in 1943, and has for a long time been recommended by the Institution to examination candidates. Although it is written "primarily for the students and inhabitants of the workshop, it has been used and appreciated by students reading for professional engineering qualifications". This edition has been revised, but the subjects dealt with are approximately the same as those dealt with in the second (1955) edition. Contents: Introduction, materials, iron and steel — The properties and treatment of iron and steel — Non-ferrous metals and alloys, alloy steels, preparation of metals — Heat processes, forging, riveting, soldering and brazing — Power, safety and care — Metal cutting — Checking and measuring of surfaces — The bench, flat surfaces, filing, chipping, scraping — Marking out, drilling, screwing — Introduction to the lathe — Chuch work, face plate, taper turning, screw cutting.

RECENT PUBLICATIONS BY THE STAFF OF THE PRODUCTION ENGINEERING GROUP OF IMPERIAL COLLEGE

1. S. Eilon. "Entwicklungstendenzen beim Bau von Fertigungsmaschinen in Englisher Sicht." Technische Rundschau, Bern, July, 1956.
2. S. Eilon. "Quantities in Batch Production." *Engineering,* September, 1956.
3. S. Eilon. "A Note on Economic Lot Sizes." I.U.C. International Conference, Rome, September, 1956.
4. S. Eilon. "Economic Lot Sizes in Batch Production." *Engineering,* October, 1956.
5. S. Eilon. "Scheduling for Batch Production." Conference, The Institution of Production Engineers, 1957; also *Journal* of The Institution of Production Engineers.
6. R. C. Brewer. "An Appraisal of Ceramic Cutting Tools." *The Engineers' Digest,* Vol. 18, No. 9, page 381.
7. R. C. Brewer. "Turning with Ceramic and Sintered Oxide Tools." Proceedings of the Conference on Technology of Engineering Manufacture, 1958.
8. R. C. Brewer. "The Numerical Control of Machine Tools." 64 pages. Published by *The Engineers' Digest.*
9. R. C. Brewer. "On the Economics of the Basic Turning Operation." Trans. A.S.M.E., Vol. 80, page 1,479.

The Council of the Institution

1959/1960

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Vice-President
H. Burke

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Vice-Chairman of Council
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B. G. L. Jackman (*Research*)
F. C. Cooke (*Papers*)
L. W. Bailey (*Library*)
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R. E. Mills (*Standards*)
K. J. Hume (*Membership*)

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R. J. C. Whitaker G. A. J. Witton

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R. V. Shah
Canada
S. S. Pritchard

Calcutta
T. R. Gupta
New Zealand
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T. H. Hunter	C. J. Mogford	D. A. Petrie

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Elected Members

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Eastern	A. B. Brook
Midlands	A. C. Turner
North Midlands	C. N. T. Manfull
Northern	A. Smith
North Western	J. P. Speakman
Northern Ireland	J. G. Easterbrook
Scotland	J. Nicolson Low
South Eastern	J. Aikman
Southern	J. W. Taylor
South Western	A. Eustace
Wales	C. LL. Griffiths

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Melbourne (Victoria, Australia)	A. G. Jones, 13 Laburnum Street, Middle Brighton, Victoria, Australia.
Melbourne Graduate (Victoria Australia)	E. K. Stephenson, 5 Olinda Street, Glen Waverley, Melbourne, Victoria, Australia.
Sydney (New South Wales)	K. G. Slorach, 98 Church Street, Castle Hill, New South Wales, Australia.

CANADA

Canada	A. M. Hand, 18 Rintella Court, Scarborough, Ontario, Canada.

INDIA

Bombay	C. R. Pal, The Crescent Iron & Steel Works Ltd., Goregaon (East), Bombay, S.D., India.
Calcutta	P. J. O'Leary, c/o Guest, Keen, Williams Ltd., 41 Chowringhee Road, Calcutta, India.

NEW ZEALAND

New Zealand	G. Stedman, 3 Harrison Avenue, Belmont, Takapuna, Auckland, New Zealand.

SOUTH AFRICA

South Africa	A. Aitken, 209-211 Pharmacy House, 80 Jorissen Street, Johannesburg, P.O. Box 10837, South Africa.

UNITED KINGDOM

Birmingham	H. W. White, "Spring Pools", 677 Birmingham Road, Lydiate Ash, Bromsgrove, Worcs.
Cardiff	C. LL. Griffiths, "Brynteg", 139 Tyntyla Road, Llwynypia, Rhondda, Glamorgan.
Cornwall	F. G. Hawke, 3 Bellevue Terrace, East Hill, Tuckingmill, Camborne, Cornwall.
Coventry	A. S. Hopkins, 39 Oaks Road, Kenilworth, Warwicks.
Derby	P. Warburton, 16 Vicarage Road, Chellaston, Derby.
Doncaster	G. R. Wimpenny, 16 Tickhill Square, Denaby Main, Doncaster.
Dundee	J. Nicolson Low, Technical College, Bell Street, Dundee.
Edinburgh	A. S. Wilson, Ferranti Ltd. (Laboratory Workshop), Ferry Row, Edinburgh, 5.
Glasgow	W. H. Marley, North British Locomotive Co. Ltd., Diesel Engine Division, 111 Flemington Street, Glasgow, N.1.
Gloucester	B. E. Gwynne Clarke, "Chez-Nous", Okus Road, Charlton Kings, Cheltenham.
Halifax & Huddersfield ...	C. W. Overin, 353 Whitehall Road, Westfield, Wyke, near Bradford, Yorks.
Ipswich & Colchester ...	H. F. Harker, Ransomes, Sims & Jefferies Ltd., Nacton Works, Ipswich.
Leeds	J. L. Townend, 26 Moor Allerton Drive, Street Lane, Leeds, 17.
Leicester & District	J. A. Stovin, 14 Queens Drive, Leicester Forest East, Leicester.
Lincoln	H. Wright, 101 Longdales Road, Lincoln.
Liverpool	(Acting) H. Mason, 51 Stairhaven Road, Liverpool, 19.
London	R. J. C. Whitaker, The Glacier Metal Co. Ltd., Ealing Road, Alperton, Middlesex.
Luton	J. F. W. Galyer, Engineering Department, Luton & South Bedfordshire College of Further Education, Park Square, Luton, Bedfordshire.
Manchester	J. P. Speakman, 223 Douglas Road, Atherton, near Manchester.
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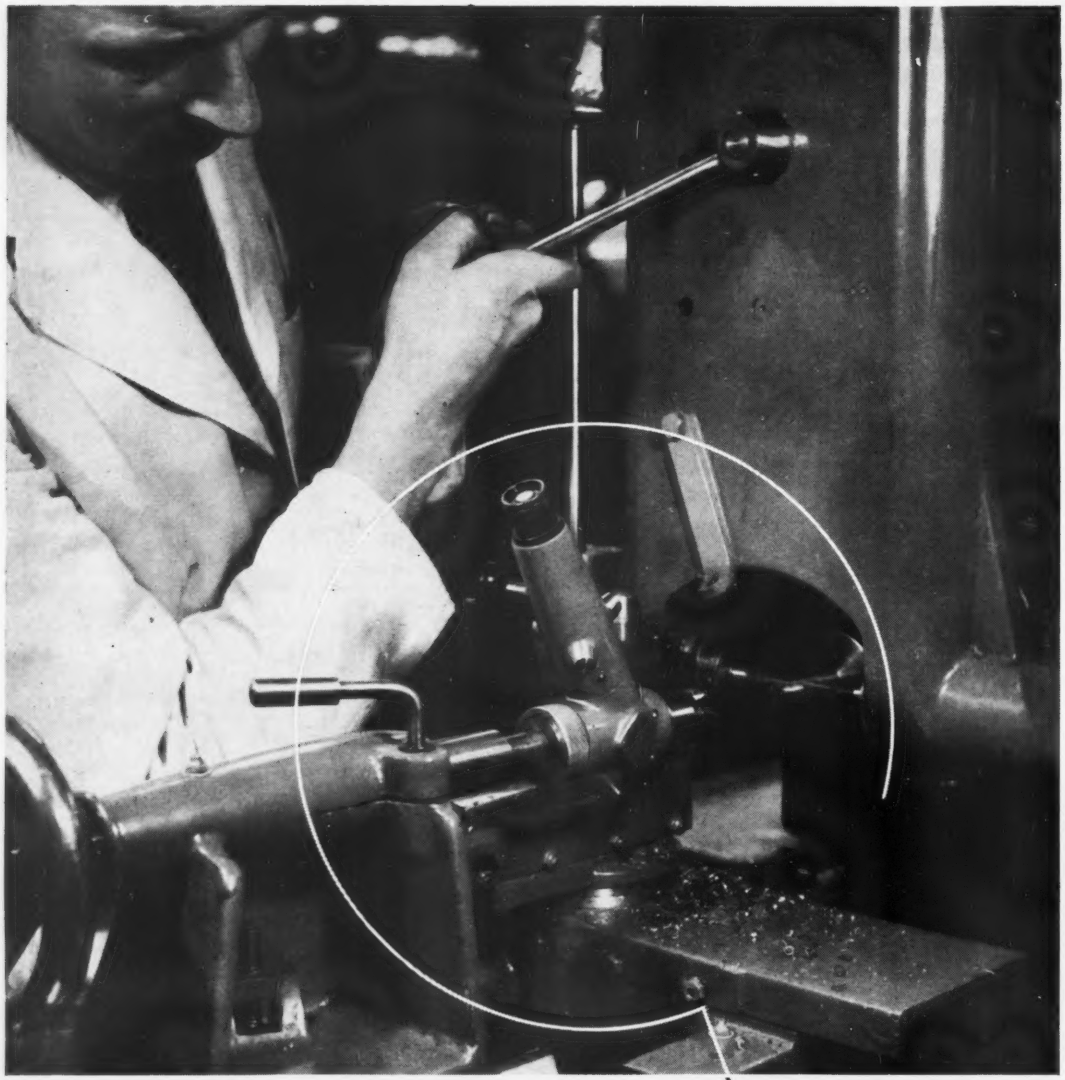


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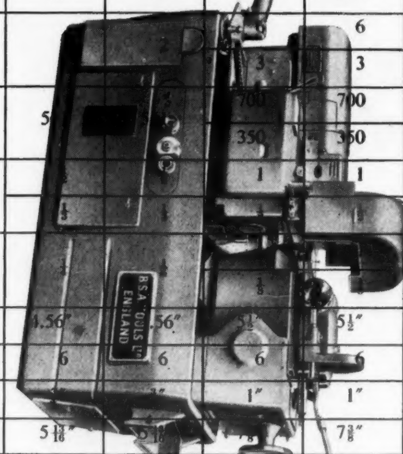
MACHINE		48	68	18L	25L	68L	88L	98L	138L	168L	METRIC 24	METRIC 36	METRIC 52
Workspindle capacity	round	1/2"	3/4"	18 mm.	25 mm.	3/4"	1"	1 1/4"	1 5/8"	2"	24 mm.	36 mm.	52 mm.
	square	.353"	1/2"	13 mm.	18 mm.	.0530"	.0708"	11/16"	1 1/8"	1.414"	17 mm.	25.4 mm.	35 mm.
	hexagon	.437"	5/8"	16 mm.	22 mm.	0.650"	0.866"	13/16"	1 3/8"	1.730"	20 mm.	30 mm.	45 mm.
Max feed in one movement	long stroke	2"	3"	75 mm.	75 mm.	3"	3"	4"	4"	4"	90 mm.	90 mm.	90 mm.
	short stroke	1"	2"			2"		2 1/2"	2 1/2"				
Stroke of turret cam (standard)		1 3/8"	2 1/4"	50 mm.	50 mm.	2 1/4"	2 1/4	3"	3"	3"	80 mm.	80 mm.	80 mm.
Max. diameter using diehead		3/8" fine	5/8" fine	16 mm.	16 mm.	5/8" fine	5/8" fine	1"	1 1/4"	1 1/4"	18 mm.	18 mm.	18 mm.
Range of spindle speeds		166—7,370	53—4,480	40—4,500	40—4,500	53—4,480	53—4,480	70—3490 24—3590	78—2300 25—2540	69—1,520	38—3,000	24—1,900	30—1,500
Number of high speeds	4 speed	18	10	14	14	10	10	22	19	17	10	10	8
	2 speed			14	14	10	10	13	12				
Low speeds available for each high speed		2	10	11—13	11—13	7—9	7—9	3—5	3—5	3—5	4—5	4—5	4—5
				9—10	9—10	6—7	6—7	8—9	7—8				
Number of cycle times		46	65	96	96	96	96	106	106	106	46	46	46
Cycle time range (secs) fastest	long stroke	3/4	2	2	2	[illegible]	2	[illegible]	6	6	8	8	8
	short stroke	3/4						3	3				
Cycle time range (secs) slowest	long stroke	75	180	561	561	[illegible]	[illegible]	700	700	700	360	360	360
	short stroke	56 1/4						350	350				
Actual time to feed stock (secs)	long stroke	1/3	1/2	1/2	1/2	[illegible]	[illegible]	1	1	1	1	1	1
	short stroke	1/4	1/3			1/3	[illegible]	[illegible]	[illegible]				
Time to change speed (secs)	long stroke	1/8	1/4	1/4	1/4	[illegible]	[illegible]	[illegible]	[illegible]	1/4	1/4	1/4	1/4
	short stroke	1/8	1/8					1/8	[illegible]				
Diameter of turret		3 3/8"	4 1/16"	116 mm.	116 mm.	4.56"	4.56"	5 1/2"	5 1/2"	5 1/2"	140 mm.	140 mm.	140 mm.
Number of turret holes		6	6	6	6	6	6	6	6	6	6	6	6
Diameter of turret holes		5/8"	3/4"	19.05 mm.	19.05 mm.	[illegible]	[illegible]	1"	1"	1"	25.4 mm.	25.4 mm.	25.4 mm.
Distance chuck to turret	max.	3 3/8"	5 3/8"	120 mm.	120 mm.	5 13/16"	5 13/16"	[illegible]	7 3/8"	7 3/8"	180 mm.	180 mm.	180 mm.
	min.	1 13/16"	2 3/8"	49 mm.	49 mm.	2 3/16"	2 3/16"	3"	3"	3"	64 mm.	64 mm.	64 mm.
Turret slide adjustment		3/16"	3/4"	21 mm.	21 mm.	1 5/16"	1 5/16"	1 1/4"	1 1/4"	1 1/4"	38.1 mm.	38.1 mm.	38.1 mm.
Spindle centre to top of cross slide		1"	1 5/16"	30 mm.	30 mm.	1 5/16"	1 5/16"	1 7/16"	1 7/16"	1 7/16"	36 mm.	36 mm.	36 mm.
Movement of cross slide		1"	1 1/4"	32 mm.	32 mm.	1 1/4"	1 1/4"	1 3/4"	1 3/4"	1 3/4"	40 mm.	40 mm.	40 mm.



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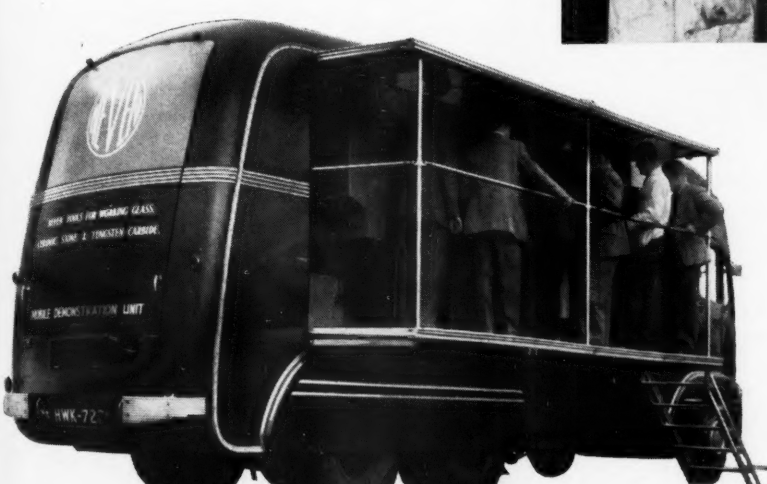
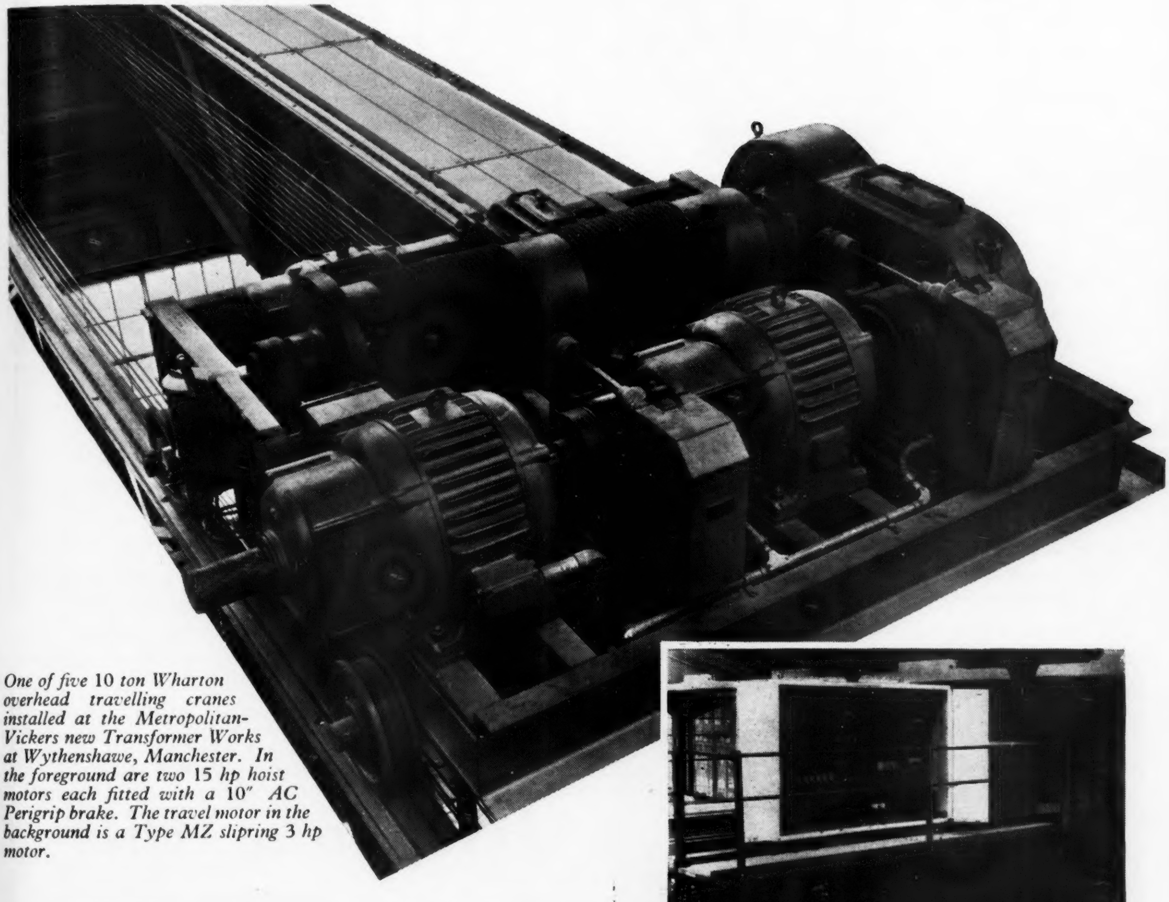
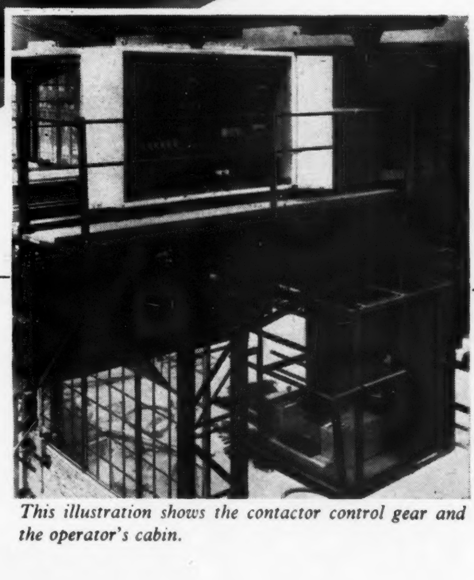


Complete Hoist Control without Mechanical Braking



One of five 10 ton Wharton overhead travelling cranes installed at the Metropolitan-Vickers new Transformer Works at Wythenshawe, Manchester. In the foreground are two 15 hp hoist motors each fitted with a 10" AC Perigrip brake. The travel motor in the background is a Type MZ slipring 3 hp motor.



This illustration shows the contactor control gear and the operator's cabin.

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Messrs. Glostics Ltd.,
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For the attention of Mr. A.D.P. Tallents.

Dear Sirs,

In January 1955 you supplied us with two shot blast nozzles in Carbon Tetra Boride. These were immediately put into use in the shot blast cabinets in our Heat Treatment department, working at an air pressure of 40 to 60 lbs/sq. in., and using 30 mesh angular chilled cast iron grit as the abrasive.

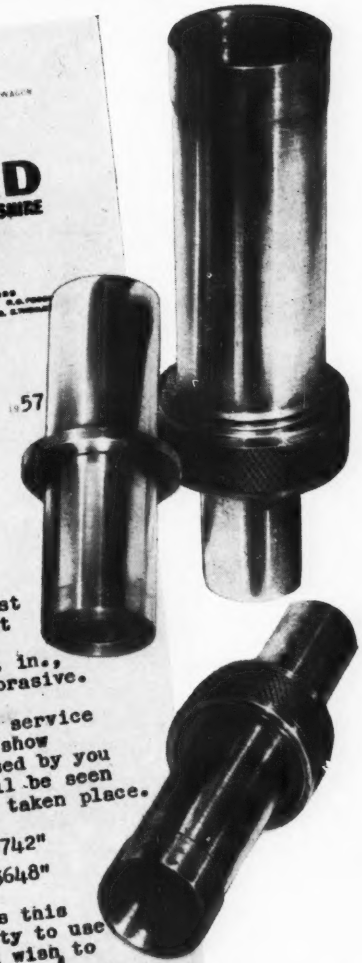
It is estimated that each nozzle has now been in service for more than 5,000 hours, and recent dimensional checks show the amount of wear to be almost negligible. We are advised by you that the original nozzle bore diameter was ⅜", and it will be seen from the following figures that little, if any, wear has taken place.

Bore Size at Throat of Nozzle	.3745" to .3742"
Bore Size 1" from Throat	.3650" to .3648"

We feel that an outstanding performance such as this should not go unnoticed, and you are therefore at liberty to use the information contained in this letter in any way you wish to further the publicising of C.T.B. nozzles.

Yours faithfully,
for FODENS LIMITED.

E.J. PHIPPS,
CHIEF METALLURGIST.



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